

# **Dialectic Approach to Multidisciplinary Practice in Requirements Engineering**

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## Abstract

This thesis develops an approach that supports multidisciplinary practice in requirements engineering. It is argued that multidisciplinary requirements engineering practice is ineffective, and some specific problems for multidisciplinary practice are identified. It is also suggested that the incommensurability of conflicting paradigms is an underlying cause of the problems in multidisciplinary practice, and a number of criteria for support to overcome such problems are proposed.

A form of methodological support, which it is claimed may help overcome some of the problems associated with multidisciplinary practice in requirements engineering, is developed. This methodological support takes the form of a dialectic process, and its associated products, which is conceptualised and then operationalised. As an illustration of the methodological support offered to multidisciplinary practice, the operationalisation of the dialectic process is applied to requirements constructed by the use of two different requirements engineering techniques from two different disciplines (representing two different paradigms), in the domain of Accident and Emergency healthcare. Finally, the application of the operationalisation of the dialectic process is assessed with respect to the criteria for support for multidisciplinary practice proposed earlier, and this assessment is used to reconceptualise the dialectic process. The limitations of the research are identified, and possibilities for future work proposed.

This thesis is aimed primarily at the requirements engineering community, and in particular the practising requirements engineer. It makes two contributions to knowledge supporting the practices of requirements engineering. First, the thesis contributes two types of *substantive* discipline knowledge: an explanation of why multidisciplinary practice in requirements engineering is problematic; and the proposal of criteria for support to allay the difficulties of multidisciplinary practice. It is suggested that these criteria might be used in the *development* of new types of support to overcome such difficulties, or in the *assessment* of new requirements engineering techniques that claim to address multidisciplinary practice. Second, the thesis contributes *methodological* knowledge in the form of a dialectic approach that offers a new way of reasoning about requirements engineering. This methodological knowledge takes two forms: a *generic* dialectic approach that might be applied by requirements engineering practitioners to requirements, generated by a wide-range of requirements engineering techniques, representing alternative paradigms; and a *specific instantiation* of the dialectic approach using the MUSE method and the Grounded Theory method, that might be used in its current form by requirements engineering practitioners to support their own multidisciplinary practice.

### **Dedication:**

This thesis is dedicated to my father, Bill (1931-1993), and my daughters, Siân (born 1996) and Ellen (born 1998).

### **Also For:**

My grandmother, Nellie Gage (1905-1998), and my mother, Joan.

### **Acknowledgements:**

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There are more things in heaven and earth, Horatio,  
Than are dreamt of in your philosophy.

Hamlet, Act I, Scene V.

or

Belief is never sure.

Lou Reed, Dime Store Mystery



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# Chapter One

## Multidisciplinary Practice in Requirements Engineering

The methods pass the problem by.  
Wittgenstein (1953)

### 1. Introduction

This thesis is concerned with multidisciplinary practice in the emerging field of requirements engineering (RE). Two types of multidisciplinary practice are distinguished:

- i) *independent* multidisciplinary practice - where each contributing discipline addresses its own requirements engineering problems without influencing, or being influenced by, other contributing disciplines.
- ii) *dependent* multidisciplinary practice - where contributing disciplines exert a *mutual influence* upon one another in the address of requirements engineering problems.

The thesis, in general, aims to develop an approach which supports reasoning about the mutual influence of discipline knowledge in RE, and is, therefore, concerned primarily with dependent multidisciplinary practice. The thesis has the following aims:

- To explore the potential and problems of dependent multidisciplinary practice in RE.
- To exemplify dependent multidisciplinary practice in RE via a case history concerning the development of an Accident and Emergency (A&E) healthcare information system for a major UK hospital.
- To develop and informally test an approach which supports dependent multidisciplinary practice in RE.

To help readers understand the structure of this thesis, there follows a brief introduction to each of the chapters it contains:



- Chapter One argues that multidisciplinary requirements engineering practice is ineffective. Specifically, the chapter characterises RE, and uses this characterisation as a framework within which to review the contributions of a number of different disciplines. Multidisciplinary practice in RE is introduced, exemplified, and its problems identified.
- Chapter Two suggests that the incommensurability of conflicting paradigms may be a possible underlying cause of the problems in dependent multidisciplinary practice that were identified in Chapter One. Criteria for support to overcome such problems are proposed.
- Chapter Three develops a form of methodological support which it is claimed may help overcome some of the problems associated with dependent multidisciplinary practice in RE. This methodological support takes the form of a dialectic process, and its associated products, which is conceptualised and then operationalised.
- Chapter Four introduces the reader to the domain in which the operationalisation of the dialectic process is to be applied and assessed; that is, Accident and Emergency (A&E) healthcare information systems. The chapter also describes the context of the field work conducted in this thesis.
- Chapter Five develops requirements for the redesign of an A&E healthcare information system from the perspective of the discipline of human factors. Human factors discipline knowledge is applied via the MUSE (Method for Usability Engineering) structured method (Lim and Long, 1994).
- Chapter Six develops requirements for the redesign of an A&E healthcare information system from the perspective of the discipline of sociology. Sociological discipline knowledge is applied via the Grounded Theory method (Glaser and Strauss, 1967).
- Chapter Seven applies the operationalisation of the dialectic process to the requirements generated in Chapter 5 and Chapter 6. This application illustrates the methodological support offered to multidisciplinary practice (by the operationalisation of the dialectic process).

- Chapter Eight assesses the application of the operationalisation of the dialectic process with respect to the criteria for support for multidisciplinary practice proposed in Chapter Two. This assessment is then used to reconceptualise the dialectic process. The limitations of the research are identified, and possibilities for future work proposed.

## 2. Characterisation of Requirements Engineering

Requirements engineering is an emerging field, and as such, there is little consensus as to the nature and scope of its concerns. Its emergence has been characterised by a proliferation of perspectives, techniques and tools, and a profusion of concepts and terms.

For the purposes of this thesis, we characterise RE in terms of four key processes (see Figure 1.0), namely:

- developing an *understanding* of the requirements problem
- the *specification* of requirements for a software product
- the *validation* of both the problem understanding and the product specification (and the relationship between them)
- the *representation* of the outputs of each process<sup>1</sup>.

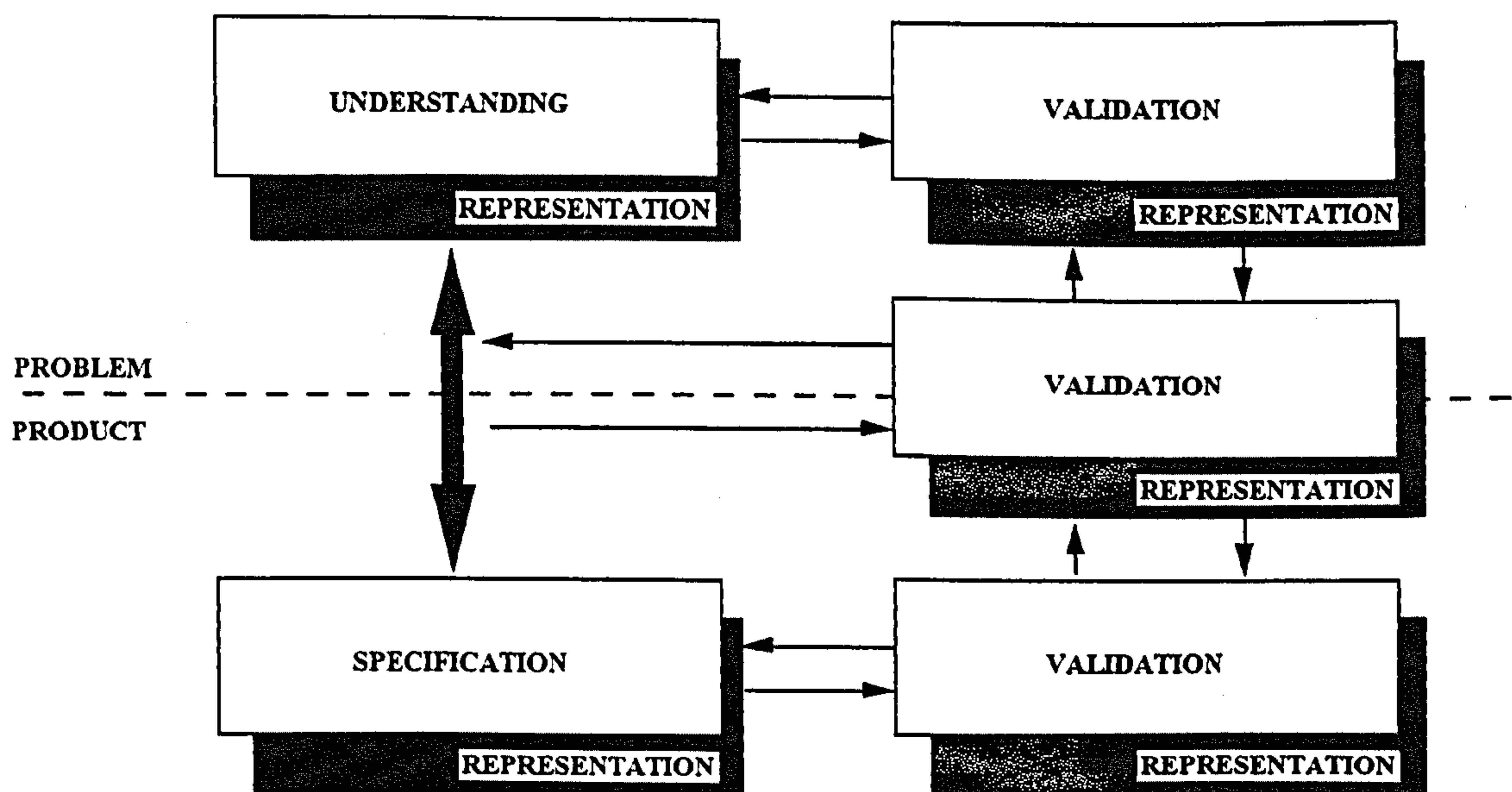


Figure 1.0: Characterisation of Requirements Engineering

<sup>1</sup> This characterisation draws in particular on six descriptions of RE (Davis, 1990,1993; Pohl, 1994; 1996 Loucopoulos and Karakostas, 1995; Wieringa, 1996; Sutcliffe, 1996; Kotonya and Sommerville, 1998) as well as the RE literature more generally.



In the following sections, each of the components of this characterisation of RE are examined briefly.

## 2.1. Understanding

Developing an understanding of a RE problem is often thought of as a process which must identify all the possible constraints which the proposed software product must meet (Davis, 1990, 1993; Wieringa, 1996). The sources of such constraints may include, for example: customers; users; developers; technology; and laws and standards. From this perspective, it is the requirements engineer's job to balance such constraints. For example, the requirements engineer may balance the needs of different interest groups (e.g. customers, users, developers, and so on) against what might be technologically possible.

It is increasingly being recognised, however, that the above view of developing a problem understanding by specifying constraints vastly oversimplifies RE problems (Sølvberg, 1994; Bubenko, 1995). For example, it may be difficult to identify and specify all the possible constraints, and even harder to establish relationships between causes and effects for RE problems (Rosenhead, 1989). Additionally, RE problems are often dynamic, and characterised by complex interactions between their constituent parts. In this sense, any potential solution will result in new interactions between the various parts of the problem (Ackoff, 1981). In support of this view, there is increasing interest in the idea that the principal difficulty in establishing system requirements is that many of the problems being tackled are often *wicked* (Sommerville, 1989; Sølvberg and Kung, 1993; Bubenko, 1995; Macaulay, 1996).

The contrast between wicked and tame problems was first formulated by Rittel and Weber (1973) in the field of public planning. A tame problem is one which can be specified, in a form agreed by any relevant parties, ahead of the analysis, and which does not change during the analysis. A wicked problem, by contrast, is ill-defined, and there are many alternative ways of explaining the phenomena of concern. Moreover, the type of explanation selected determines the nature of the solution. A number of traits of wicked problems (as identified by Rittel and Weber, 1973) are summarised in Table 1.0. Each trait is accompanied by a comment that illustrates why requirements engineering problems may be thought of as examples of wicked problems.



Tame Problems (after Rittel and Weber, 1973)	Wicked Problems (after Rittel and Weber, 1973)	Requirements Engineering Problems
<b>1. Ability to formulate the problem</b> Tame problems can be clearly defined, and they contain all the information the problem-solver needs to understand and solve the problem.	Wicked problems have no definitive formulation, and finding the problem is the same thing as finding the solution. The process of solving the problem is identical with understanding its nature.	Requirements engineering problems are multi-voiced: they almost always involve trying to make sense of a complex web of relationships among many stakeholders all of whom have a different view of the problem, most of which will change with time.
<b>2. Knowing when to stop</b> When solving a tame problem, the problem solver knows when the job is done. There are criteria that indicate when <i>the</i> or <i>a</i> solution has been found.	Wicked problems have no end-point.	Requirements are typically considered to be volatile, situated, and continually changing. They can only be arbitrarily 'frozen' at a particular point in time (typically constrained by resources). Recent work from ethnography is addressing the issue of requirements evolution (Goguen, 1996).
<b>3. Testability</b> The solution to a tame problem can be tested against objective criteria. The solution is either correct or it is incorrect, and errors can be pinpointed.	Wicked problems have no true or false answers. Solutions are judged by the parties involved. Their assessments of proposed solutions may be expressed as 'good' or 'bad' or, more likely, as 'better' or 'worse' or 'good enough'.	Although some requirements can be tested against objective criteria (e.g. system response times to user input), many requirements can only be determined and evaluated when a system is in use, or through the use of prototypes, (e.g. organisational requirements).
<b>4. Predictability</b> The solution to a tame problem has predictable consequences; and the effect of its implementation will be known.	Solutions to wicked problems, once implemented, will generate waves of unintended effects, and the full consequences cannot be appraised until the waves of repercussions have completely run out.	Requirements problems often have a organisational/social or political dimensions, which militate against guaranteed outcomes for any implementation.
<b>5. Influence</b> Solutions to tame problems can be tried out without influencing the final outcome. Dry runs are not penalised.	With wicked problems, each trial solution leaves traces that cannot be undone.	The actions (or very presence) of a requirements engineer in the workplace influences user expectations and irrevocably changes the problem situation. Similarly, using prototypes to elicit and validate requirements changes user expectations about the system and its possible properties.
<b>6. Tractability</b> There is an exhaustive list of permissible operations that can be used to solve a tame problem.	In the pursuit of wicked problems, any number of alternative plans of action may be feasible. It is a matter of judgement which of these should be pursued.	Requirements engineering techniques can be created, selected and configured to meet the demands and constraints of the situation at hand (Macaulay, 1996). The skill and judgement of the engineer is often crucial to their successful application.

Table 1.0: Requirements Engineering Problems are Wicked Problems (continued overpage)

Tame Problems (after Rittel and Weber, 1973)	Wicked Problems (after Rittel and Weber, 1973)	Requirements Engineering Problems
<b>7. Replicability</b> Tame problems reoccur.	Wicked problems are essentially unique.	Even when there are apparent similarities, the requirements engineer can never be certain that the particulars of a current problem situation do not override its commonalities with situations already dealt with.
<b>8. Boundedness</b> Tame problems are well-bounded. They have an identifiable form, and there is no need to argue about the level of analysis.	Every wicked problem can be considered to be a symptom of another problem. The level at which the problem is settled cannot be decided on logical grounds.	Requirements can be expressed at many levels. High level requirements are often too general for the purposes of engineering a solution. Low level requirements are easier to meet, but may be marginal to the 'real' problem. Bounding a requirements engineering problem is typically an argumentative process.
<b>9. Explanations</b> For tame problems, there is a single and clear explanation for the gap between 'what is' and 'what ought to be'.	Wicked problems have many possible explanations for the same discrepancy. Depending on which explanation one chooses, the solution takes on a different form.	Many requirements are derived from a particular stakeholder's explanation of the problem to be solved. Whether to accept or reject a particular requirement depends on the plausibility and/or desirability of its associated explanation. What is deemed to be plausible and desirable depends to a large extent on the style of decision making being used (autocratic, democratic, consensual, technocratic etc.).
<b>10. Responsibility</b> Solving a tame problem is a 'morally neutral' activity, insofar as an identical solution could, in theory, have been reached by any another person attempting to solve the problem using the same techniques.	The wicked problem solver has no such moral immunity and must take some responsibility for the consequences of their actions.	Requirements engineers use their judgement in the framing and analysis of problems, and as such must accept some responsibility for the impact they make on other people's lives. Requirements engineering is a political activity which takes place within a framework of political, social, organisational and technological constraints.

Table 1.0: Requirements Engineering Problems are Wicked Problems (continued)



## 2.2. Specification

It is widely agreed that the requirements engineering phase of the software lifecycle ends with the creation of an explicitly structured document called the software requirements specification (SRS), which describes in detail the proposed software product, acts as a blueprint for the development of the proposed software system, and serves as the basis for all subsequent phases of the software life-cycle (Sommerville, 1989).

The requirements specification process, then, transforms the problem understanding into a desired output (i.e. the SRS document), but the process itself is iterative since the construction of the requirements specification may require the accumulation of more knowledge about the problem (and conversely the accumulation of more knowledge about the problem may trigger changes in the specification). Similarly, completion of some part of the specification may require validation (and conversely a negative result in validation may trigger changes in the specification).

There are a number of published standards which define the kind of requirements to be included in a requirements specification and the structure in which they should be documented. For example, the IEEE-Standard 830 (IEEE, 1984) distinguishes between functional and non-functional requirements. Where functional requirements define the transformations that system should perform on inputs in order to produce some output; and non-functional requirements are the constraints that can be placed on a system (including security, portability, performance etc.). Similarly, British Standard 6710 (BSI, 1986) distinguishes between vital requirements (which must be achieved by the system), and desirable requirements (which are optional, or may be met with some degree of flexibility). More specific types of requirements may also be identified, including: organisational requirements (Dobson et al, 1994); user requirements (Carlshamre, 1996); interaction requirements (Carey and Mason, 1986); and interface requirements (Chapanis and Budurka, 1990).

Additionally, standards typically detail desirable elements and characteristics of a SRS. For instance, it is frequently stated that a SRS should be: complete; unambiguous; verifiable; consistent; understandable by customer; traceable; modifiable; and so on. Some of these desirable characteristics, however, may often be more apparent than real. For example, a complete SRS should describe everything that the software is supposed to do, but as Blum (1994) has suggested every requirements specification must be incomplete, since users seldom know everything about what the product should do, and a truly complete specification would be isomorphic to its implementation. This point highlights the importance that is given to validation of the requirements specification with customers and users who must provide their *agreement* that the specification is complete with respect to their needs.



## 2.3. Validation

Throughout the RE process, each person involved will have a personal view of what is required. Some of these views may be shared with others, but many will not, and the RE process must allow for different possible views whilst supporting evolution from these views to common agreement (Pohl, 1994, 1996). In this sense, validation is concerned with reaching agreement on a common problem understanding and a common product specification, as well as agreeing that there is correspondence between the understanding and the specification themselves. Validation proceeds in parallel with both understanding and specification, and implies a check on consistency, accuracy, relevance, acceptability, desirability, feasibility and so on, amongst all interested parties (including users, customers, and developers).

Validation is critical to the whole RE process, since without common agreement on both the understanding and the specification the likelihood of system acceptance is reduced (Macaulay, 1996), and the likelihood of the need for costly error corrections is increased (Boehm, 1975, 1981; Basili and Weiss, 1981; Tavolato and Vincena, 1984).

## 2.4. Representation

Different representations may be used for expressing knowledge about the problem understanding and the product specification. Broadly speaking, we can identify three categories of representation: informal; semi-formal; and formal. Informal representations include: natural language, arbitrary graphics, and descriptions by examples and animations. Semi-formal representations include: structured diagrams; entity relationship diagrams; data flow diagrams, and so on. Formal representations include formal languages such as: VDM (Jones, 1980); Z (Spivey, 1989); or knowledge representation languages such as ERAE (Dubois et al, 1988).

Each of these categories offers some advantages and disadvantages. For example, informal representations are user-oriented and flexible. Semi-formal representations provide a good overview of the system, and are widely-used in industrial contexts. Formal representations have rich, well-defined semantics, and reasoning about most of the represented knowledge is possible. Formal languages are system oriented, and may even be used to generate code. Also, because different representations are used at different times (and often in parallel), it is important that they be kept consistent.

The choice of representation may simply reflect the preferences of the parties involved in requirements engineering. A social scientist, for example, may use natural language; whilst a software engineer might use a formal language. More generally, however, formal models are central to the software process, since without them, software engineers cannot reason about the correctness of either a design or an implementation (Blum, 1992, 1994). Put another way, formality reduces the ambiguity of requirements, and allows the specification of



intended product behaviour in way which supports both the design and testing of the proposed system. Consequently, the software process always culminates in the creation of formal models, and it is to the advantage of software engineers to have formal models as early in the process as possible. For this reason, most frameworks and models of RE agree that the process should culminate in the creation of formal models (e.g. Davis, 1990; Wieringa, 1996), and there is consistent interest in the development of formal languages in RE.

## **2.5. Summary**

This section has introduced and characterised requirements engineering in terms of four key processes, namely: understanding; specification; validation; and representation. In the next section, we look at the nature of multidisciplinary contributions to these processes.

## **3. Multidisciplinary Requirements Engineering**

There is increasing interest in the notion that requirements engineering may be multidisciplinary in nature (Scaife et al, 1994; Luff et al, 1994), as the following two recent definitions illustrate:

Requirements engineering is the elicitation, definition, modelling, analysis, specification and validation of the needs of a computer system. It is multi-disciplinary and draws on techniques from software engineering, knowledge acquisition, cognitive science and the social sciences to improve software engineering practice.

British Computer Society:  
Requirements Engineering Specialist Group 1994

Requirements Engineering is a multi-disciplinary area that concerns the acquisition, modelling and validation of requirements for information systems. In requirements engineering, human and organisational factors are as important as technical factors. Reference disciplines include information systems, software engineering, sociology, cognitive and organisational psychology, human-computer interaction, computer-supported co-operative work, linguistics, and philosophy.

1st Australian Workshop on  
Requirements Engineering 1996

Broadly speaking, such a multidisciplinary view of requirements engineering is necessitated by the interaction of two factors:

- i) the recognition of the important role played by the requirements phase of the system development lifecycle in determining the effectiveness<sup>2</sup> of interactive computer systems
- ii) the realisation that as computer technology becomes more powerful and reliable, human, organisational, social, and political factors become increasingly important determinants of the effectiveness of interactive computer systems.

These two points are considered in more detail below.

i) *Importance of the requirements phase*: it has long been recognised that the requirements phase is the foundation upon which the rest of the system development lifecycle is built, and that errors<sup>3</sup> in the requirements phase have a number of adverse consequences for the effectiveness of the resulting system (Boehm, 1975). There are two reasons for this. First, as shown in Figure 1.1, errors left undetected become compounded.

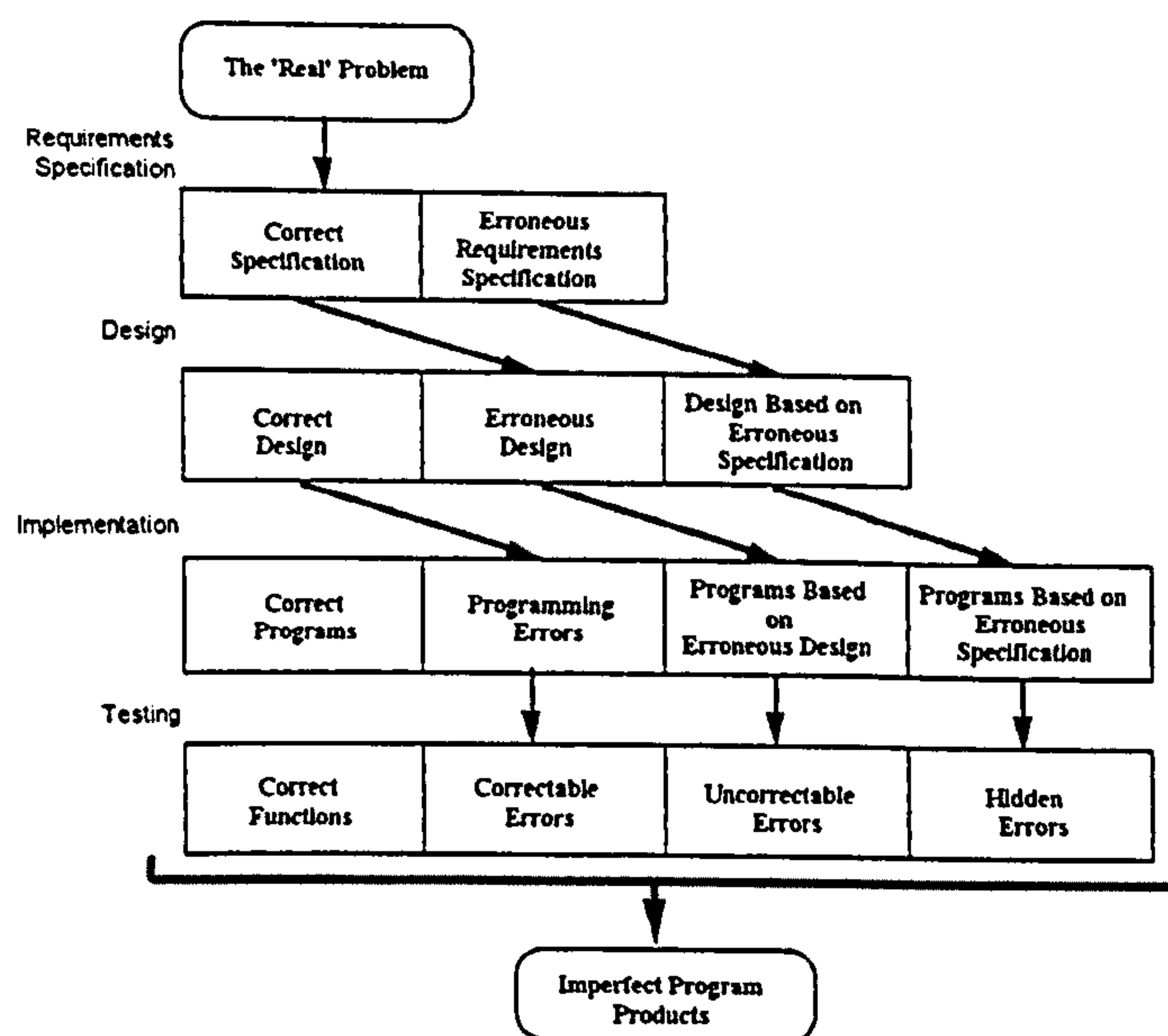


Figure 1.1: Cumulative Effects of Error (After IEEE, 1983)

<sup>2</sup> Dowell and Long (1989) have proposed that the *performance* of an interactive worksystem in carrying out its work can be defined as a function of two factors: the *quality* of the product (i.e. the outcome of the work); and the incurred *costs* (i.e. the resources required to accomplish the work). A most *effective* interactive worksystem would minimise the costs in performing work with a given product quality. In line with this distinction, system developers face the problem of designing effective interactive worksystems. That is, they must ensure (through their system development process) that the system can deliver products of the appropriate quality at acceptable costs.

<sup>3</sup> Requirements errors are interpreted broadly, but are taken to include: incorrect requirements; missing requirements; inconsistent requirements; ambiguous requirements; and so on (Basili and Weiss, 1981).



Second, errors left undetected are extremely costly. It has been calculated that the cost of correcting a software error or making software changes is a factor of 100 times greater in the maintenance phase than the requirements phase of a large project (Boehm, 1981; see Figure 1.2).

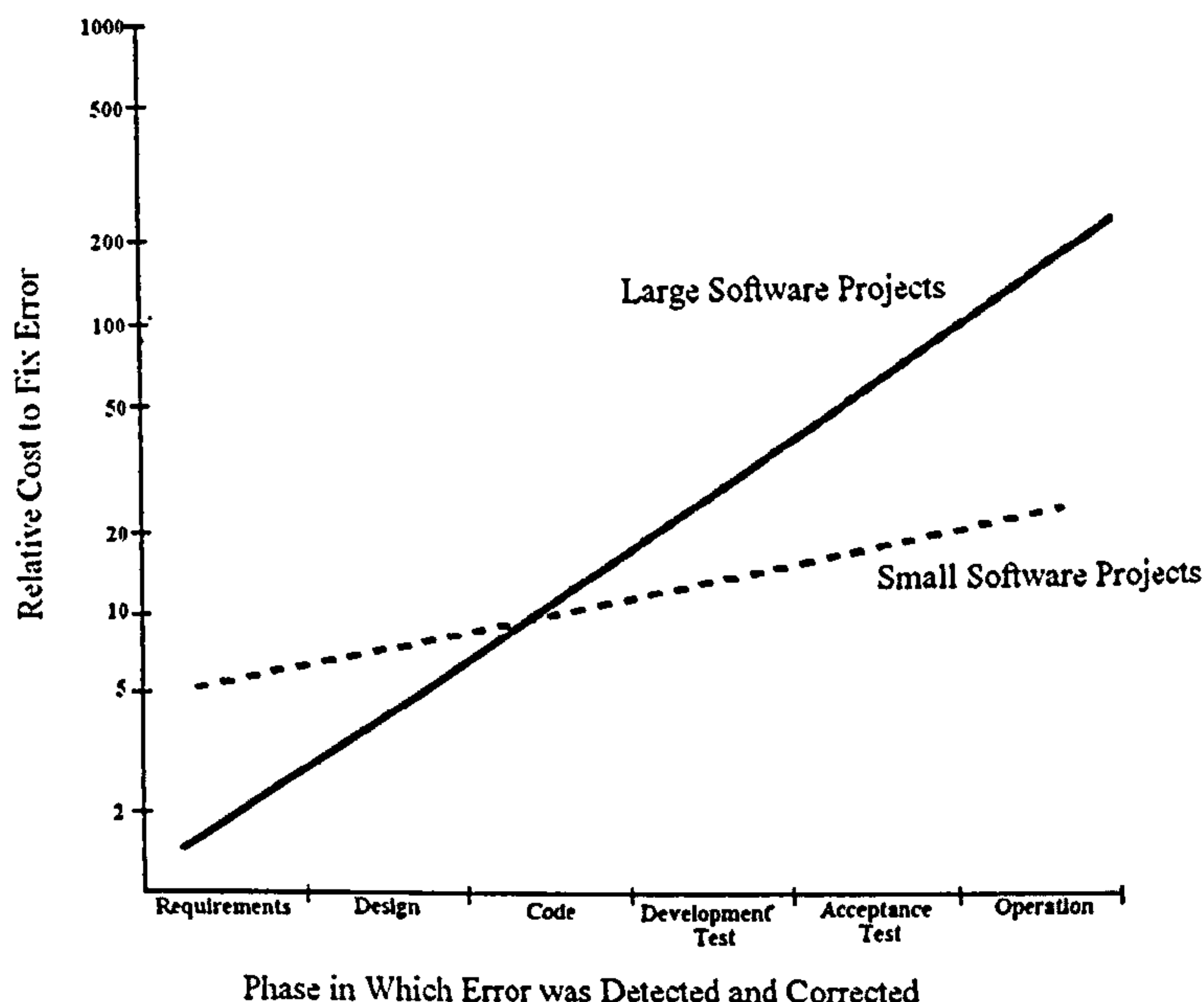


Figure 1.2: Relative Cost of Fixing Errors w.r.t. System Development Phase

Also, as Lim and Long (1994) point out, if the cost of correcting errors is too high, then they may indeed not be corrected, and the system will remain ineffective.

ii) *Importance of human, organisational, social, and political factors*: as computing technology becomes cheaper, faster, and more reliable (with concomitant increases in information and control capabilities), the effectiveness of interactive systems is increasingly influenced by social and organisational factors surrounding their introduction (Long, 1992; Bubenko, 1995). Indeed, it is becoming commonplace for technically sound systems to fail because they do not take into account the organisational, political and social context in which they are to be used (Robinson, 1994; Collins and Bicknell, 1997). Two recent examples of this type of failure include: the London Ambulance Service Computer Aided Despatch system (Page et al, 1993); and the Wessex Health Authority Regional Information System (Cross, 1997).

Given this broad perspective, and given the important influence of the requirements phase on system effectiveness, it is not surprising perhaps that a wide range of disciplines seek to offer contributions to the emerging field of requirements engineering. A number of such contributions are examined below.

### 3.1. Discipline Contributions to Requirements Engineering

The following sections identify some of the disciplines<sup>4</sup> that contribute to RE, and describe their respective contributions in terms of the methods and techniques they provide, and the type of requirements they are concerned with. This analysis is facilitated using the characterisation of requirements engineering developed in Section 2.

We will be primarily concerned with contributions from:

- Computer science and software engineering
- Human-computer interaction, human factors, and cognitive psychology
- Sociology and the social sciences
- Organisational psychology, social psychology, and the soft systems movement

#### 3.1.1. Computer Science and Software Engineering

Computer science is primarily concerned with developing techniques to support software design, development and maintenance. It addresses the mathematical and algorithmic processes that describe and transform information (Denning et al, 1989); and provides knowledge about the capabilities of technology. Computer science can be thought of as the theoretical basis for software engineering (Somerville, 1989), but software engineering applies such theoretical contributions within an engineering and management framework which include:

- making and maintaining software systems (e.g. software design, coding, program testing, software integration testing, documentation and version control);
- devising tools and methods for making and maintaining software systems (e.g. specification methods, languages and notations, debugging tools, editors and utilities);
- managing the whole software development process within economic constraints such as cost and timescale (Macro and Buxton, 1987).

With respect to RE process characterised in Section 2 above, software engineering plays a number of key roles.

In terms of *understanding*, software engineering contributions are based on the traditions of systems analysis. The systems analyst typically accumulates knowledge by interviewing customers and users, and reading all available documentation (including procedures documents, statements of need, and so on). To analyse and synthesise knowledge about the problem, the analyst may use a number of semi-formal techniques such

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<sup>4</sup> The selected disciplines are considered to be representative, but not exhaustive.



as structured analysis (e.g. Structured Requirements Definition, Orr, 1981), and object-oriented analysis (Booch, 1991; Coad and Yourdon, 1991).

In general, such techniques typically attempt to describe the RE problems in terms of the phenomena of the application domain (Jackson, 1995). Davis (1993), for example, suggests that a problem understanding comprises objects, functions, and states. Where: an *object* is some relevant real-world entity; a *function* is task, service, process or activity that is now being performed in the real-world, and/or is to be performed by the system under development; and a *state* is a condition of a system, object, or function that determines how they will behave in specific circumstances.

There is also increasing interest in the idea of domain analysis and the reuse of requirements (e.g. Bolton et al, 1994; Kösters et al, 1996; Lam et al, 1998). Domain analysis recognises that many software systems share similar application domains, and advocates that the analysis results from one system can be applied to the analysis of a similar one. Domain analysis assumes that different applications in the same domain might share similar sets of concerns. For example, in the healthcare domain, many applications would share objects such as *patients*, *investigations*, and *diagnoses*. Domain analysis suggests that in such cases, these concepts should be abstracted and organised in libraries to facilitate reuse. Loucopoulos and Karakostas (1995) consider that domain analysis dramatically reduces the effort necessary in understanding requirements problems, and reduces requirements specification to the selection and retrieval of the contents of an appropriate library. The amount of effort devoted to requirements validation may also be reduced, since the contents of the library have also been previously validated.

Problem analysis often runs in parallel with more formal techniques for specifying the software product (see next section). Indeed, studies of the behaviour of analysts (Vitalari and Dickson, 1983; Sutcliffe, 1990; Sutcliffe and Maiden, 1992) suggest that systems analysts: often formulate hypotheses concerning the nature of the solution as information is collected about the problem; and use previous design experience to classify problems and search for missing data.

As implied above, a large proportion of software engineering contributions to RE focus on product **specification** rather than problem analysis (Jackson, 1995). From a software engineering point of view, specification is characterised by the need for precision and rigour particularly where software quality and reliability is critical to the success of the proposed product. Because of this emphasis, the specification process from a software engineering perspective is intimately bound to the use of formal representations and languages (see below), and has led to the formalisation of semi-formal techniques, including: the formalisation of structured analysis and design (e.g. Greenspan, 1984); and the formalisation of entity-relationship models (e.g. Hagelstein, 1988). Formal methods (e.g.: *VDM*, Jones,



1980; and Z, Spivey, 1989), which are frequently based on mathematical formalisms such as predicate calculus and set theory, are also used to arrive at formal specifications.

In general, specification is often thought of as the key to holding-off a premature commitment to design, and yet many authors (and most development projects) either explicitly or implicitly accept that design influences the specification process. Sommerville (1989), for instance, considers that the creation of the requirements specification document might be carried out in parallel with some high-level design, and that the design and requirements activities influence each other as they develop. Work at the design stage, for example, may show that some requirement specification cannot be met as stated (or that some performance level can be easily exceeded), or new requirements may be uncovered because of some previously unconsidered factor (e.g. available hardware). Additionally, new requirements are often derived after some initial design has been performed. Goguen and Linde (1993) go further still, and believe that many of the activities of requirements engineering are done by programmers and managers relatively near, or even after, system delivery.

Some requirements tools and techniques originating from software engineering formalise this influence of design by including in the requirements specification the architectural components of the system (e.g. Structured Analysis and Design Technique, Ross, 1977; PSL/PLA, Teichrow, 1977; Reubenstein, 1994; Shekaran, 1994) or even module specifications (e.g. Structured Requirements Definition, Orr, 1981).

From a software engineering point of view, *validation* is most commonly thought of as a 'debugging' or 'quality assurance' activity (Loucopoulos and Karakostas, 1995). The aim of such an activity is to identify and correct all the errors (such as: incorrect facts; omissions; inconsistencies; redundancies, and ambiguities) as early as possible, since errors in the requirements phase are common (Bell and Thayer, 1976), and ultimately lead to excessively high maintenance costs (Boehm 1981).

Furthermore, requirements validation is often a time-consuming and painstaking process. For this reason, validation from a software engineering perspective is often supported by automated tools which perform tasks such as checking for multiple definitions, keeping track of concepts, checking for inconsistencies, and so on (e.g. Loucopoulos and Champion, 1988; Anderson and Durney, 1993).

Tool support can also be provided to enable the communication of formal software engineering requirements models to users for validation. There are, for example, a number of paraphrasing tools that convert formal specifications into natural language (e.g. Myers and Johnson, 1988; Ozcan and Siddiqui, 1994).

Validation with users can also be facilitated using working models of the system (prototypes). From a software engineering perspective, an efficient way to create a prototype is using an *operational specification*, which is a system model that can be



evaluated or executed to generate the behaviour of a system (Zave, 1984; Agresti, 1986; Accosta et al, 1994). From a requirements engineering point of view, an operational specification is typically constructed from informal and incomplete system requirements. Its key benefit is that at least some validation of the behaviour of the proposed system can occur early in the development process.

In terms of *representation*, software engineering has contributed to the field of requirements engineering by providing a plethora of formal and semi-formal languages and notations. Much of the impetus behind the development of such representations is the notion that the concept of a textual requirements document is deeply flawed insofar as it is prone to deficiencies such as incompleteness and inconsistency. For example, diagrammatic techniques such as data flow diagrams (DeMarco, 1979), and entity-relationship diagrams (Chen, 1977) have been used for many years as alternatives to textual requirements documentation. These diagrammatic conventions are typically used in order to reduce the volume of necessary documentation, and also improve communication and understanding. Such semi-formal representations are used to define and organise ideas, and are essentially concerned with understanding the requirements problem.

Semi-formal representations are frequently transformed into more formal representations that allow requirements engineers to verify the correctness of the proposed system. More recently, however, a number of authors have explored the potential of formal descriptions to contribute understanding requirements problems. Yu (1993), for example, has developed notations that support the formal modelling of organisational goals.

This concludes our examination of the contribution of the disciplines of software engineering and computer science to requirements engineering (as characterised in Section 2). The next section examines the contribution to requirements engineering of the disciplines of human computer interaction, human factors and cognitive psychology.

### 3.1.2. Human-Computer Interaction, Human Factors, and Cognitive Psychology

Human-computer interaction can be broadly characterised as the design, evaluation, and implementation of interactive computing systems for human use, and the study of major phenomena surrounding them (ACM SIGCHI 1992). As this definition implies, HCI is a diverse field whose scope has grown and shifted in response to technological developments that affect human interactions with machines. For example, HCI incorporates the concerns of human factors, insofar as it addresses the design of artefacts that meet the physiological capacities and capabilities of users (e.g. the design of workstations or the presentation of information on visual display units). HCI also incorporates the concerns of cognitive psychology, insofar as it addresses human behaviour and the mental processes and structures that underlie it (e.g. information processing, problem solving and so on). More recently,



alternative psychological frameworks which address work amongst groups of users (e.g. distributed cognition) have extended the range of HCI concerns still further.

With respect to the RE process characterised in Section 2 above, HCI plays a number of important roles.

In terms of *understanding*, HCI contributions to RE include conducting user studies and producing descriptions or models of the activities that people perform when performing work in particular contexts.

Techniques for conducting user studies are widely reported in the literature and include: direct observation of users during their normal work (Diaper, 1989); indirect observation of users using video recording (Harrison, 1991); the gathering of verbal data from users via interviews (Cordingly, 1989), and verbal protocols (Bainbridge, 1979; Ericsson and Simon, 1985); and the elicitation of user opinions and attitudes via surveys and questionnaires (Shneiderman, 1992). There is also increasing interest in co-operative requirements capture techniques (Macaulay, 1993; Monk et al, 1993) which promote increased user/stakeholder involvement in developing a requirements understanding.

Descriptions or models based on user studies focus on the tasks or processes carried out by users, and aim to provide insights into the functionality of the proposed system, or to predict the usability of proposed designs. Typically, such descriptions and models address criteria such as performance, error behaviour, learnability, acceptability, user satisfaction and so on. The Keystroke Level Model (Card, Moran and Newell, 1983), for example, provides predictions of performance in terms of speed of operation. Similarly, task models, such as those provided by Hierarchical Task Analysis (Annett and Duncan, 1967; Shephard, 1989) and Operational Sequence Diagrams (Phillips et al, 1988), may be used to describe current task behaviour or to understand and predict the performance of alternative task sequences.

In terms of *specification*, Diaper (1989) has suggested that task analysis is potentially the most powerful method in the field of HCI for producing requirements specifications. Carey et al (1989), for example, use Hierarchical Task Analysis (HTA) for functional specification of user requirements. Similarly, Walsh (1989) suggests that his Analysis for Task Object Modelling (ATOM) method may be used in the analysis of user requirements and the specification of user interfaces. Task Analysis for Knowledge Descriptions (TAKD) has also been used to produce interface requirements (Diaper, 1990).

Moreover, recent work in HCI has attempted to improve the capability of HCI to contribute to specification activities via the integration of human factors methods with traditional structured methods to provide a complementary user-orientation; for example, JSD\*HF (Lim et al, 1992); and SSADM (Damodoran et al, 1988).

In terms of *validation*, HCI contributions to RE centre on the presentation and evaluation of various types of system images (Norman, 1986) such as prototypes,



simulations, animations, and story-boards with users. The purpose of such validation activities is to obtain user feedback on the proposed system, and clarify its characteristics and behaviour, including: required functionality; appropriate representations; the look and feel of the user interface; requirements for user support, and so on. Such validation activities can exhibit varying degrees of formality ranging from informal presentations to controlled experiments.

Software prototyping (in particular) can help considerably when the requirements for a system are not well understood. For example, prototyping is a useful way to obtain requirements about the user interface of the system. The use of software prototypes has a number of advantages over the validation of requirements documentation which users often have difficulty in commenting on, and which in any case is often poor at representing user interactions.

Various kinds of prototype may be developed to elicit different kinds of information. For example: rapid prototyping (where prototypes are subsequently discarded or thrown-away) recognises that requirements are likely to be inaccurate when first specified; evolutionary prototyping (where the initial prototype evolves into the final system) supports changing requirements as the proposed system becomes better understood; and incremental prototyping (where elements of the system are installed in phases) allows requirements to be checked in the field so that changes to core features are possible (Preece et al, 1994).

In sum, prototyping provides good support for the elicitation of user requirements, and a good way of validating the user's intentions. A frequent problem with the prototyping approach, however, is that users may view the prototype as the actual solution rather than just a mock-up, and this can lead to misunderstandings, resistance to change, and sometimes to unrealistic expectations of system potential. In the case of throw-away prototyping, users may also hold unrealistic expectations about development schedules.

In terms of *representation*, HCI contributions to RE, often consist of pictorial representations (such as story-boards and prototypes), but in the case of task analysis may also include various types of diagrams and other supporting notations (such as tables) which are used to represent task hierarchies, task sequences, possible task options, and possible iterative relationships between tasks (see Lim and Long, 1994; Diaper, 1989). The bulk of HCI contributions, then, tend to be informal or semi-formal in nature, but there have been some attempts to provide more formal representations of HCI contributions to RE. Harrison and Barnard (1993), for example, have developed notations that support the formal modelling of usability requirements.

This concludes our examination of the contribution of the disciplines of human computer interaction, human factors and cognitive psychology to requirements engineering (as characterised in Section 2). The next section examines the contribution to requirements engineering of the disciplines of sociology and the social sciences.



### 3.1.3. Sociology and the Social Sciences

There is increasing interest in requirements engineering in particular, and system design more generally, in social influences affecting the use of computer systems in a particular work context (Suchman, 1987; Randall and Twydale, 1993; Anderson, 1994). This interest has led to the use of a number of ethnomethodological techniques originating in sociology and the social sciences to describe and analyse such influences, including: ethnography (Jirotko and Goguen, 1994); discourse analysis (Goguen and Linde, 1993); conversation analysis (Heath and Luff, 1992); and interaction analysis (Button, 1990; Cooper et al, 1995).

Ethnomethodological techniques have a long tradition within sociology and anthropology. Broadly speaking, ethnomethodology is used to produce detailed descriptions of the lives and social activities of people within specific communities or contexts. In requirements engineering, ethnomethodological approaches are seen as a way to explore and record the richness of formal and informal social interactions that take place around technology within the context of the workplace.

In terms of *understanding*, sociological contributions to RE focus on the need to take account of organisational structure, culture, and the work practices of users. For example, Goguen (1994, 1996) suggests that ethnomethodological approaches reveal the organisational culture as seen by the members of that organisation themselves, and that the analytic categories uncovered by the process can be used to develop an understanding of potential requirements.

In developing such an understanding, multiple methods (e.g. fieldwork, observations, textual analysis, etc.) may be used depending on the context of the study and the sorts of questions being asked (Nelson, et al, 1992). The choice of tools to use, or which research practices to employ, are not set in advance, but are configured to fit local demands and constraints. The aim, then, is to focus on activities as they actually occur during the course of work, and the emphasis is on description rather than explanation (Kuutti and Karasti, 1994) or specification (see next section).

In terms of requirements *specification*, there is little evidence as yet to demonstrate how ethnomethodological approaches can be used prescriptively. Jirotko and Goguen (1994), for example, consider that it is not yet apparent how to construct requirements from ethnographic analyses. Similarly, Button and Dourish (1996) suggest that the incorporation of ethnomethodological understandings into the specification of software products has been problematic.

Much of the work in the application of ethnomethodological approaches to the specification of requirements is concerned with how the formulation of requirements can be 'informed' by descriptively rich sociological descriptions. For example, Randall et al (1994) describe the experience of an interdisciplinary team of sociologists and computer scientists collaborating in the design of a computer support for air traffic management. They report



that although the ethnomethodological approach could not identify a specific software requirement, it did help the designers obtain an impression of the kind of facilities required by the air traffic controllers (though they do not claim a literal traceability between the ethnography and the requirements specification). Similarly, Somerville et al (1993) suggest that ethnomethodological approaches do not result in specific requirements, but rather provide pointers to appropriate design decisions.

A number of authors have looked at ways to improve the applicability of ethnomethodological approaches to specification. One approach, for example, is to supplement ethnography with the use of video recordings to allow repeated analysis of activities in real-world environments with the aim of answering specific questions posed by system developers (Luff et al, 1992; Randall and Twidale, 1993).

Another way in which applicability might be improved has been proposed by Button and Dourish (1996) who suggest that from the requirements engineer's perspective, ethnomethodologists might also act as a proxy for users in the field (or more accurately a proxy for the field-setting itself). Similarly, Bentley et al (1992) propose that ethnographers might act as the user's champions during the specification process.

For Anderson (1994), however, such attempts at improving applicability may be misguided. He suggests that rather than contributing to prescriptive practices, ethnomethodology may allow a radical rethinking of those practices and an examination of the 'dogma of formalism'. Broadly speaking, this position argues that we should explore the fundamental foundations of systems design via the application of an ethnomethodological study of design itself.

There are two aspects of the ethnomethodological approach which are important with respect to the *validation* of RE information. First, the ethnographer is conceived as embedded in the context of study, and not simply as an observer separate from that context (Button and King, 1992; Anderson, 1994). Second, members are held accountable for certain significant actions by their group, and may be asked to provide an account (i.e. a justification) for their actions (see Goguen, 1996). Because the members' categories and methods are identifiable through the ways that members are held accountable by their group, analysts should be able to understand the social interactions of the group, if they can discover the methods and categories that the members themselves use to make sense of their interactions.

Through immersion in the work context of some particular group, then, an analyst gradually acquires specific competencies that allow them to represent the subjective point of view of the members in that social context (Goguen, 1996). With respect to requirements validation, then, the resulting ethnographic record represents a set of shared understandings generated by the participants in an interaction, and should be intelligible to those participants



as the articulation of the publicly recognised circumstances, structures, categories, and experiences of their everyday working life (Holstein and Gubrium, 1994).

The *representations* produced by ethnomethodological approaches typically consist of fieldworkers' notes and observations, including remarks, snippets of conversations, quotes, maps, descriptions of the physical environment and so on. Such representations may be integrated into ethnographic records that are typically highly qualitative, highly detailed, impressionistic, natural language descriptions (Randall et al, 1994). From an ethnomethodologist's point of view, the move from such a natural language record to the formal and mathematical representations typically employed in the writing of an SRS, inevitably loses much of the texture of the 'real world' of working life (Randall et al, 1994).

This concludes our examination of the contribution of the disciplines of sociology and the social sciences to requirements engineering (as characterised in Section 2). The next section examines the contribution to requirements engineering of the disciplines of organisational psychology, social psychology and the soft systems movement.

### 3.1.4. Organisational Psychology, Social Psychology, and the Soft Systems Movement

For the purposes of this thesis, we will group organisational psychology (Clegg and Frese, 1996), social psychology (Vaske and Grantham, 1990) and the soft systems movement (Checkland and Haynes, 1994) as those disciplines that, taken together, are essentially concerned with the relationship between the behaviour of people in groups and the form and function of organisations. The sorts of issues tackled by these disciplines include: organisational structures and processes; work and job design; the management of change; conflict and negotiation; authority and power; attitudes and values; the links between technology and work; and so on.

With respect to requirements engineering, there are two discernible but interrelated types of contribution from organisational psychology, social psychology and the soft systems movement. The first type of contribution is concerned with the identification and formulation of the actual organisational, enterprise, or business requirements which computer systems must meet (e.g. Dobson and Strens, 1994; Champion and Moores, 1996; and Bustard et al, 1996). The second type of contribution is concerned with ways to facilitate worker involvement in the design of computer systems through the use of participative or cooperative techniques (e.g. Bjerknes and Bratteteig, 1987; Macaulay, 1996). Both of these types of contributions are considered below.

In terms of *understanding*, organisational psychology, social psychology and soft systems contributions to RE focus on the processes by which an understanding of system requirements is developed. Broadly speaking, such contributions pay careful attention to the perspectives of various stakeholders in the process.



For example, the ETHICS (Effective Human and Technical Implementation of Computer Systems) method (Mumford and Weir, 1979) is based on socio-technical systems theory (Emery and Trist, 1969), and consequently places considerable emphasis on the need to recognise that there is no distinct boundary between the technical and the organisational/social systems. ETHICS includes criteria for improving job satisfaction and job design, and is used by requirements engineers as a technique for problem analysis that produces a list of tasks and objectives to be achieved.

ETHICS has much in common with participatory design (Carmel et al, 1993). Participatory design seeks to improve requirements engineering by creating improved relationships between analysts and users. These improved relationships are achieved by ensuring continuous team work, shared decision-making between analysts and users, the development of a shared understanding of work problems and the impact of new technology, and the building of consensus (Holtzblatt and Beyer, 1995).

Participatory design has its roots in the Scandinavian tradition of workplace democracy, and as a consequence has strong political overtones (Kjaer and Madsen, 1995). Not surprisingly, a number of specific requirements engineering methods originating from the participatory design stable include techniques to explore the ideological emphasis behind problem explanations and requirements (e.g. UTOPIA, Bødker et al, 1987; DEMOS, Ehn and Sandberg, 1983; FLORENCE, Bjerknes and Bratteteig, 1987).

Finally, perhaps the most widely used technique for establishing organisational requirements, and also for facilitating the process of exploring requirements problems, is the soft systems methodology (Checkland, 1981; Checkland and Scholes, 1990). Soft systems methodology does not seek to analyse a problem, but seeks to explore the situation in which there is perceived to be a problem. The problem situation is examined from multiple stakeholder perspectives, and the methodology seeks to reach consensus on requirements and solutions that are considered by the stakeholders to be both desirable and feasible. The methodology develops abstract models of the purposes and activities of the organisational system being examined, and compares these models with the actual situation in order to identify appropriate changes (which may or may not include the development of a computer system).

There have been a number of attempts to utilise the soft systems methodology in the design of computer systems, including: the MULTIVIEW method (Wood-Harper et al, 1985), and Structured Systems Analysis and Design (Downs et al, 1992) where it is combined with systems analysis techniques; the MEASUR (Methods for Eliciting, Analysing and Specifying User Requirements) method (Stamper and Kolkman, 1991; Stamper, 1994) where it is combined with the formal specification of social norms; the FAOR (Functional Analysis of Office Requirements) method (Schäfer et al, 1988) where it is part of a suite of tools used to define the scope and objectives of an office requirements analysis; and the



RACE (Requirements Acquisition and controlled Evolution) method (Bustard and Lundy, 1995; Bustard et al, 1996) where it is combined with object-oriented analysis.

In terms of *specification*, the organisational perspective represented by organisational psychology, social psychology and the soft systems movement supposes that the purpose of building a software system is to satisfy some business or enterprise objectives. Indeed, a number of authors (e.g. Bubenko et al, 1994; Yu and Myopoulos, 1994; Loucopoulos and Karakostas, 1995) suggest that organisational requirements need to be represented in a requirements specification in terms of an explicitly stated definition of the enterprise in which the system will eventually operate. This view has led to a number of techniques for specification of *enterprise models* (e.g. Nellborn et al, 1992; Yu, 1993; Dobson et al, 1994). An enterprise model typically aims to describe social and organisational systems in a formal way, often in terms of concepts such as: organisational structures; objectives and work goals; activities processes and products; agents and work roles; obligations and responsibilities; and so on. The ORDIT approach to organisational requirements (Dobson et al 1994 etc.), for example, attempts to provide a means to specify organisational requirements by using a modelling language that defines concepts such as: role, responsibility, agency, action, and resources (Blythe et al, 1993). This language is used to construct and validate a set of 'semiotic' models, which specify the structure and properties of organisational requirements as solutions to socio-technical problems (Dobson and Strens, 1994).

A number of other requirements engineering methods also incorporate enterprise models in their specification phase, including: MEASUR (Stamper, 1994) which attempts to locate responsibility using a technique for business enterprise analysis; and RUBRIC (Van Assche et al, 1988) which is concerned with capturing and responding to changing business requirements using a rule based specification which incorporates business knowledge into the specification process.

In terms of *validation*, contributions to RE from our three 'organisational' disciplines typically employ processes (such as workshops and group sessions) which actively involve customers and users in requirements validation, encourage designers to interact with users, and employ explicit cycles aimed at building consensus on what actions to take.

The Cooperative Requirements Capture (CRC) method (Macaulay, 1993, 1996), for example, uses facilitated group sessions with relevant stakeholders to develop and validate a shared understanding of the target users' organisational setting, the work that the users do, and the scope of the proposed system. Similarly, the Joint Application Design (JAD) method (August, 1991; Andrews, 1991; Crawford, 1994) also uses facilitated group sessions to validate business objectives, high level requirements (including anticipated benefits, strategic future considerations, assumptions and constraints), and technological options.



Both CRC and JAD use a range of validation techniques including: focus groups (Draper and Oatley, 1991); metaphorical design (Kensing and Munk-Madsen, 1991); cooperative prototyping (Bødker and Grønbaek, 1991); and cooperative evaluation (Monk et al, 1993).

In addition to these consensus-building approaches, the validation of proposed organisational requirements can also be supported by methods of negotiation and conflict resolution (e.g. *Argnoter*, Stefik et al, 1987). Such methods of conflict resolution are often based on behavioural and organisational theories, and some of them offer satisfaction measures (e.g. *Synoptic*, Easterbrook, 1994).

In terms of *representation*, communication with organisational representatives is facilitated using user-friendly graphical representations such as rich pictures (Checkland, 1981) to illustrate organisational issues, structures, processes and the general operational climate. User participation in constructing suitable representations is often encouraged. For example, participative design may sometimes include cooperative prototyping (Bødker and Grønback, 1991), where users are actively involved in the design of prototypes rather than just in their evaluation.

For the purposes of communication with designers, however, more formal enterprise models may be used. Enterprise models typically employ semi-formal and formal diagrams to articulate viewpoints and organisational concepts, and more particularly to operationalise organisational goals (e.g. Loucopoulous and Karakostas, 1995). Such notations typically include representations for structural relationships and behavioural relationships, but may also include representations for organisational decision making, flows of control and so on (e.g. Blythe et al, 1993).

This concludes our examination of the contribution of the disciplines of organisational psychology, social psychology and the soft systems movement to requirements engineering (as characterised in Section 2).

### 3.1.5. Summary

In the above sections, we have summarised a number of discipline contributions to understanding, specification, validation and representation in requirements engineering, including: software engineering, human-computer interaction, social sciences, and organisational psychology and so on.<sup>5</sup> Such contributions describe what sort of discipline knowledge and practices might be used during system development in order to understand and/or solve different aspects of a requirements problem.

In the next section, we will look at the nature of multidisciplinary practice *per se*.

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<sup>5</sup> This list could, of course, be extended to include still more disciplines that might have an impact on the field of RE such as: linguistics in the understanding and analysis of requirements information such as transcripts of conversations; marketing in the analysis of customer needs for off-the shelf software; law in the clarification of requirements specifications as legal contracts; and so on.

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## 3.2. Multidisciplinary Practice

Despite the wide range of contributing disciplines, and the almost *de facto* belief that requirements engineering is a multidisciplinary area, surprisingly little attention has been paid to the nature of multidisciplinary practice *per se*. In the light of this belief, this section has the following aims:

- to distinguish between possible types of multidisciplinary practice in requirements engineering
- to illustrate and exemplify multidisciplinary practice in requirements engineering
- to review examples of multidisciplinary practice in requirements engineering

## 3.3. Types of Practice Involving Multiple Disciplines

For the purposes of this thesis, we distinguish between two general types of practice involving contributions from multiple disciplines:

- i) *independent* multidisciplinary practice - where each contributing discipline addresses its own requirements engineering problems without influencing, or being influenced by, other contributing disciplines
- ii) *dependent* multidisciplinary practice - where contributing disciplines exert a *mutual influence* upon one another in the address of requirements engineering problems

These two types of multidisciplinary practice are discussed below.

### 3.3.1. Independent Multidisciplinary Practice

In the case of independent multidisciplinary practice, the contribution to the requirements engineering process provided by one discipline and its practitioners does not affect in any way the contribution of other disciplines and their practitioners. Each discipline addresses its own requirements engineering problems (see Figure 1.3).

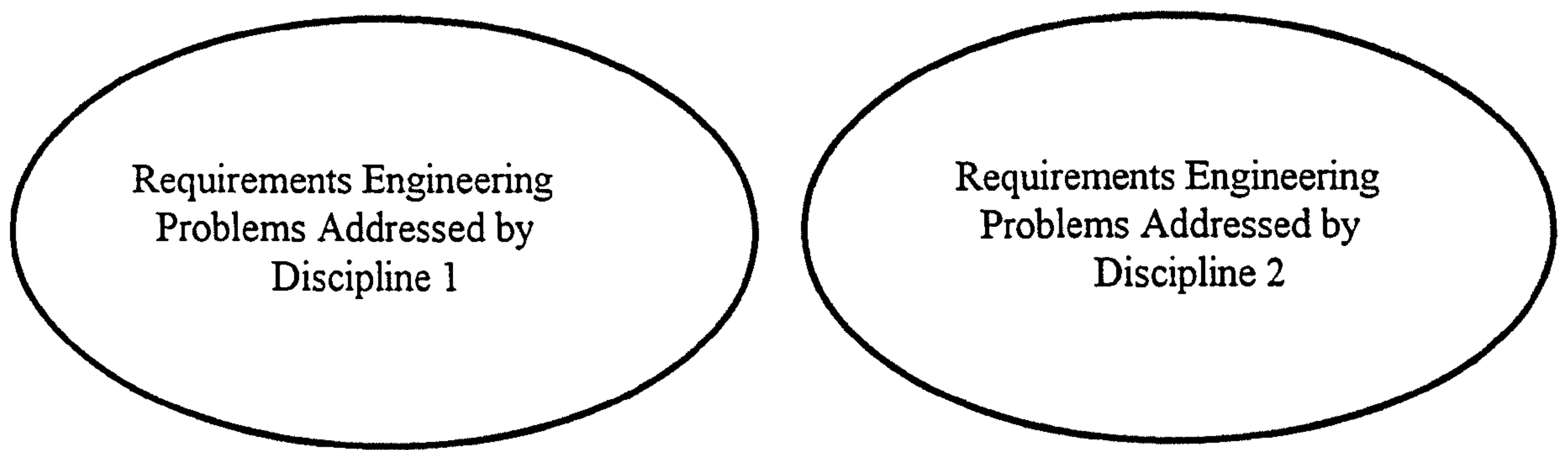


Figure 1.3: Independent Multidisciplinary Practice in RE

For instance, imagine a scenario where the directors of an hospital are re-designing their A&E department to improve its efficiency and effectiveness to cope with increasing demands and diminishing resources (see also Chapters 4 and 6). This redesign might consist of two components:

- redesign of the department's organisation and management structures
- procurement of a new information system

If the re-design is carried out using a process of independent multidisciplinary practice, it is possible that the organisational structures could be re-designed without consideration of the new information system, and *vice versa*. For example, practitioners of the discipline of organisational/management psychology (management consultants, for example) might identify a requirement to change the hierarchical structure amongst A&E staff to one based on multi-professional team working. However, practitioners of the discipline of software engineering (specialist software developers, for example) might identify a requirement to design the A&E information system around an official NHS minimum data set for an A&E department (including generic tasks such as: registering patients; triaging patients; recording diagnoses and treatments; ordering tests; admitting patients; discharging patients; and so on - see also Chapter 4) without consideration of the proposed new team-working structure.

In this case, knowledge and practices from the discipline of organisational/management psychology have been applied independently of knowledge and practices from the discipline of software engineering.

### 3.3.2. Dependent Multidisciplinary Practice

In the case of dependent multidisciplinary practice, the contribution to the requirements engineering process provided by one discipline and its practitioners does not occur in a vacuum, but in the context of the other disciplines and their practitioners which also offer



contributions. That is, contributing disciplines exert a **mutual influence** upon one another (see Figure 1.4).

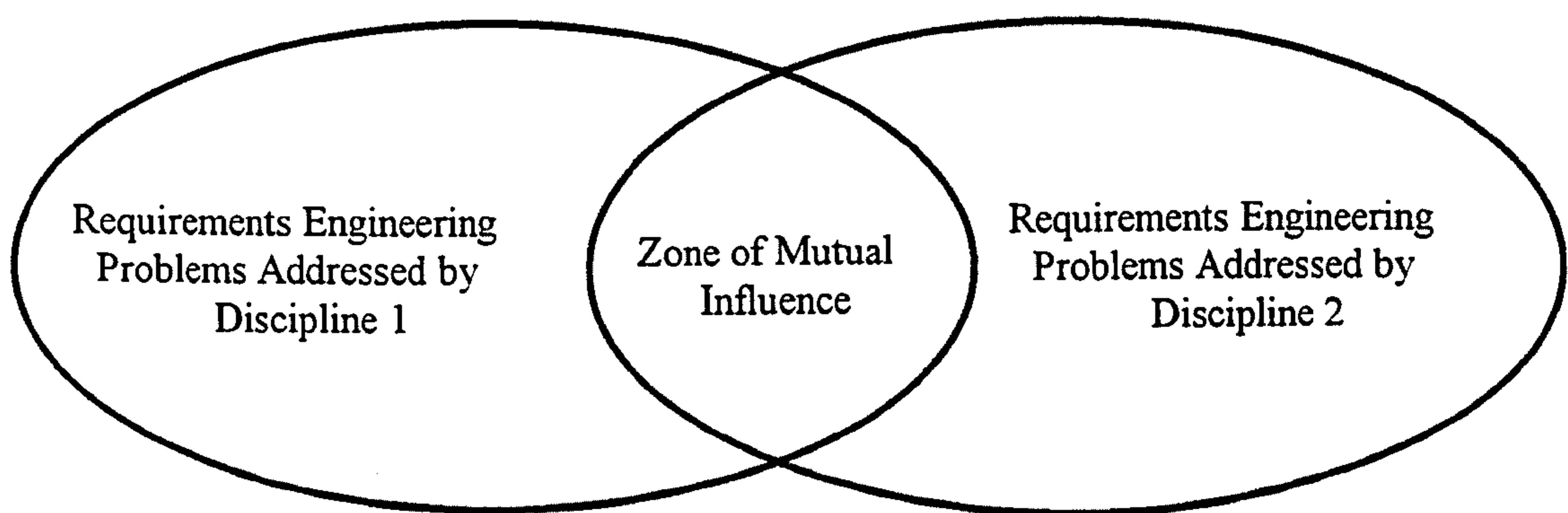


Figure 1.4: Dependent Multidisciplinary Practice in RE

For instance, in system development more generally, the disciplines of human factors and software engineering exert a mutual influence in the context of the design of user behaviours and computer behaviours at the user interface (Ashby, 1956; Dowell, 1993). Similarly, the disciplines of human factors and sociology exert a mutual influence in the context of the design of user behaviours for multi-user systems.

To illustrate this point, let us extend the A&E example used above (see Section 3.3.1). Imagine that the hospital directors have identified a business requirement (specified in their Statement of Need) to introduce electronic communication between the A&E department and the pathology laboratory, because paper-based investigation requests often go ‘missing’ between the A&E department and the pathology laboratory. Using human factors knowledge and practices (by applying task analysis, for instance) the system developer might identify that doctors currently fill-out and sign the paper-based investigation request forms. The developer might then reasonably suggest that this task should continue to be allocated to the doctor on introduction of the computerised system, and might therefore suggest that doctors should also complete the electronic investigation request forms (with their login identification verifying their identity as a person able to order investigations). However, by conducting an ethnographic study the system developer might discover that A&E doctors perceive data input tasks as largely administrative (and detracting from the real job of caring for patients), and will only use the computer system for information retrieval. As far as the A&E doctors are concerned, all data input tasks should be performed by nurses. In this instance, then, it is not possible for the system developer to simply utilise the two discipline contributions independently of one-another. Instead, the developer must seek to understand how these two contributions are related, and how they might influence

each other in the formulation of a suitable requirement for the design of the investigation ordering system.<sup>6</sup>

### 3.3.3. Types of Dependent Multidisciplinary Practice

This section considers some of the ways in which dependent multidisciplinary practice can be carried out<sup>7</sup>.

For the purposes of this thesis, we identify four types of dependent multidisciplinary practice, these are:

- by concept
- by product
- by process
- by practitioner

Multidisciplinary practice by concept might occur if the very foundations of Discipline 1 and Discipline 2 were integrated within a common framework or theory (perhaps resulting in the formation of an hybrid discipline). There are no such theories or frameworks within the field of requirements engineering at present, though some authors (Potts, 1997; Potts and Newstetter, 1997) have described the need for a synthesis of abstractionist and contextualist 'design philosophies' in requirements engineering.

Multidisciplinary practice by product might occur when a practitioner of Discipline 1 commissions a requirements study from a practitioner of Discipline 2, and is due course receives a product (e.g. the results of an analysis) which can be considered in relation to products from their own discipline. Multidisciplinary practice in this case is organised primarily around the use of substantive discipline knowledge. Somerville et al (1998), for example, use a *viewpoints* framework (see Finkelstein et al, 1992; Darke and Shanks, 1996), to make explicit the relationships between multiple discipline perspectives (including mechanical engineering and ergonomics) in the specification of requirements for an on-board train protection system.

Multidisciplinary practice by process might occur if a practitioner of Discipline 1 learns a technique from Discipline 2 and incorporates it into his/her repertoire of techniques. Multidisciplinary practice in this case is organised primarily around the use of methodological discipline knowledge. This type of multidisciplinary practice is often

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<sup>6</sup> This example is revisited in Chapter 3, and completed in Chapter 7.

<sup>7</sup> For the purposes of this thesis, we assume that the characterisation of requirements engineering described in Section 2 is applicable, irrespective of the discipline contributions under consideration.



advocated: Macaulay (1996), for instance, suggests that requirements engineers should have a large number of requirements engineering techniques in their portfolio; and Sutcliffe (1997) and Sutcliffe and Ryan (1998) describe a technique combination approach, which provides additional support for the requirements engineer in the form of a process guidance method. However, as Sutcliffe (1997) admits, it can be hard for practitioners to acquire sufficient skills to apply a wide variety of techniques.

Multidisciplinary practice by practitioner might occur if a practitioner of Discipline 1 collaborates with a practitioner of Discipline 2 in a requirements study. In this case, both practitioners will use their training and judgement to respond to specific concerns, and it is the practitioners themselves who are channels for their respective discipline knowledge. This thesis, is primarily concerned with dependent multidisciplinary practice by practitioner, and this type of practice is exemplified in more detail below.

## **4. Examples of Dependent Multidisciplinary Practice by Practitioner**

This section examines a number of case histories of multidisciplinary practice in requirements engineering. There are three case histories, involving collaboration between the disciplines of:

- i) psychology and software engineering (two case histories)
- ii) sociology and software engineering (one case history)

Each of the case histories is an example of dependent multidisciplinary practice by practitioner.

### **4.1. Psychology and Software Engineering**

This section examines two case histories of multidisciplinary practice between psychology and software engineering. The first case history concerns the development of a computer based system to support interactive student learning (Gasson, 1995). The second case history concerns the development of a software tool to support fashion designers in producing new ideas for future seasons (Scaife, Curtis and Hill, 1994).

#### **4.1.1. Multidisciplinary Practice in the Development of a Computer Based System to Support Interactive Student Learning**

Gasson (1995) conducted a study of a multidisciplinary practice between psychologists and software engineers in the development of a computer-based system to support interactive student learning<sup>8</sup>. The study was based around the analysis of design documents

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<sup>8</sup> As part of a larger study that aimed to examine to what extent users are excluded from decision-making processes in information system development, and by what mechanisms users may be excluded.

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produced by the development team (comprising three psychologists and three software engineers), and interviews with project team members.

The project plan specified an integrated design and development process model which was to be followed by the development team. This process model aimed to support collaboration of both groups in requirements analysis, design, development, and evaluation of a number of software prototypes (and is hence an example of multidisciplinary practice by practitioner).

This integrated process model, however, broke down almost immediately. Gasson speculates that from the beginning, there was a dichotomy of approach between the two disciplines, and that team members from both disciplines failed to understand the requirements of the other discipline, or learn from each other. The project quickly became polarised into two 'camps', with each side asserting the primacy of their understanding to the design process. Both groups attempted to control the development process: the psychologists by defining project plans and workpackages with the project sponsor; and the software engineers by separating the technological development of the system from the psychologists' user studies.

This situation led to two isolated streams of work, with formal communication via the production of 'official' project documents (e.g. rival requirements specification documents). Even such formal 'communication' was more apparent than real, as these documents were at best ignored and at worst left unread (negating the possibility of multidisciplinary practice by product). Eventually, the project was abandoned.

Dependent multidisciplinary practice by practitioner was clearly not successful in this instance, insofar as there was no meaningful collaboration between the two groups of practitioners, and no mutual influence exerted between discipline contributions.

#### 4.1.2. Multidisciplinary Practice in the Development of a Software Tool to Support Fashion Designers

Scaife et al (1994) report a case study of a multidisciplinary project that aimed to develop a software tool for fashion designers to use in producing design ideas for future seasons. The development team comprised four people, two software engineers and two psychologists/cognitive scientists.

The case study focuses on some of the difficulties of software development that arose from the interaction between the software engineers and the psychologists/cognitive scientists. Such difficulties were particularly marked in the early stages of the project during the translation of empirical data requirements into specifications. The authors report some specific problems of that data handover exercise and present an analysis of their causes. The case study is based upon detailed records of over twenty design meetings, each of which lasted between one and three hours.



The case study reports that a major problem for the development team was a lack of shared assumptions about the development process. Disagreements arose about: how and when to make design decisions; the respective merits of low-fidelity and high-fidelity prototypes; whether the design process should be top-down (e.g. 'specify then implement') or bottom-up (e.g. 'implement and test'<sup>9</sup>); and the relative effort that ought to be spent on user interface design and the design of the 'functional core' of the system. The authors conclude that many of these differences in approach are derived from the disciplines of the people involved.

The authors suggest that the team found it very difficult to accomplish a translation of results from the fieldwork into a piece of software. Methodologically, many of the team's difficulties were related to what the 'correct' way of working should be, and the differing rationales for design decisions (which in turn were driven by differing discipline perspectives). There were also problems with understanding terminologies across disciplines.

Despite these problems, a working prototype was produced, and was well received by users. In contrast to our first case study, the authors conclude that on the whole the collaborative experience was a positive one, and that both groups of practitioners learned something about multidisciplinary working, despite the very real difficulties in the development process that were attributable to the different backgrounds of the people involved.

## **4.2. Sociology and Software Engineering**

This section examines a case study of multidisciplinary practice between sociology and software engineering.

### **4.2.1. Multidisciplinary Practice in the Development of an Electronic Flight Strip to Support Air Traffic Controllers**

This case study concerns the requirements for a user interface to a flight database which is used to provide real-time information to air traffic controllers (essentially, an electronic flight strip). Our analysis here is constructed from four published reports of the project; two authored from the perspective of the software engineers (Somerville et al, 1992, 1993); and two authored from the perspective of the sociologists (Hughes et al, 1993; and Randall et al, 1994). As with our previous examples, this case study represents an example of multidisciplinary practice by practitioner. In this case, multidisciplinary interactions were organised around monthly debriefing meetings.

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<sup>9</sup> See Denley and Long (1990)



Generally speaking, both the sociologists and the software engineers have positive views on their collaboration. However, both groups report a number of residual problems, which are discussed below.

By virtue of their technical expertise in specifying and implementing computer systems, the software engineers held a dominant position as *de facto* 'guardians' of the system development process. This dominant position meant that sociological inputs to the development process were guided by the needs of that process as interpreted by the software engineers. Somerville et al (1992), for example, remark that the software engineers found it difficult to derive any systematic means of identifying key system requirements from the ethnographic record.

In response to this problem, the software engineers put four specific questions to the sociologists which they felt to be important (these concerned options for automation with respect to the manual system). For the sociologists, these questions were invalid, insofar as they compromised their complex, subtle, and holistic descriptions of the air traffic controllers' work practices, and reduced the social organisation of work to a series of discrete tasks that ignored the specifically social properties of the work (Randall et al, 1994).

For the sociologists, the software engineers' questions and their own response to them was a problem of viewpoint, and the different interests that the disciplines take in the world and how these are instantiated in practice (Randall et al, 1994). However, whilst accepting the principle of this position, the software engineers argued that in practice the building of computer systems cannot be accomplished without the making of pragmatic decisions about what to automate and what not to automate. Somerville et al (1992) remark that the sociologists ultimately accepted that they could not opt out of judgements about the processes which they were studying. This acceptance signalled the end of the 'innocence' of the sociologists with respect to the designers' concerns, and from then on the software engineers' questions gradually shaped the sociological fieldwork towards the focus of the design activity (namely the flight strips) and away from an understanding of the work practices of the controllers more generally (Randall et al, 1994). Indeed, Hughes et al (1993) suggest that the software engineers were more interested in the detailed and specific ways in which the flight strips were worked with than the social organisation of the controller's work more generally. Hughes et al (1993) go as far as to suggest that sociological theory is largely ill-suited to the design process, since its disciplinary interests have not been directed to any kind of applied role, and that sociological studies of work will have to begin anew in order to develop the necessary discipline knowledge for system designers to draw upon. This view is supported perhaps by the fact that the sociological analysis did not deliver any explicit software requirements, and there is not literal traceability



between the ethnography and the specification of the system components (Randall et al, 1994).

Three other classes of problem were also identified by the collaborators, namely: *communication*, *methodology*, and *comprehension*.

*Communication*: Terminological problems were common, insofar as each discipline used standard English words in specialised ways. Some examples of words that caused misunderstandings were 'semantics', 'abstraction', and 'model'. For instance, the software engineers produced a mathematical specification of some abstract data types which they claimed defined the 'semantics' of those entities. For the sociologists, meanings are socially negotiated, and the thought that the software engineers might capture their sense by mapping them onto a mathematical system was alien (at best).

*Methodology*: The methodologies of software engineering and sociology are very different. The methodology of software engineering is based around the demonstration of the feasibility of concepts by building systems, and the use of abstractions to produce generic rather than specific solutions by (Somerville et al, 1993). The methodology of sociology (and in particular, of the sort of ethnography used by the sociologists in this instance) is based on observation. Sociologists are concerned with the detail of specific social situations; and are reluctant to make abstractions. Furthermore, sociologists are not normally concerned with proposing 'solutions' to 'problems'. However, an awareness of these alternative methodologies did not help the two groups reconcile their differences, and the software engineers have expressed concern at their failure to use sociological research in the system development process in a systematic way (Somerville et al, 1992).

*Comprehension*: Both disciplines found problems in understanding what the other discipline practitioners actually do. The computer scientists found it hard to understand the alternative theoretical frameworks available within sociology, and failed to develop a general model of the discipline of sociology. Similarly, the sociologists had comparable problems in understanding the system development process, and implementation details in particular.

In sum, then, both the software engineers and the sociologists felt that the collaboration was successful with some provisos. Somerville et al (1992), for instance, suggest that there is a wide gulf between the disciplines based on entrenched philosophical positions, and that future successful collaboration requires that both disciplines question further their own assumptions and working methods (see also Hall, 1997).

### 4.3. Problems in Dependent Multidisciplinary Practice by Practitioner

The case studies examined above all identify similar problems with dependent multidisciplinary practice by practitioner. These include:

- dichotomy of approach between the two disciplines
- problems of viewpoint, and the different interests that the disciplines take in the world
- lack of shared assumptions (about the system development process)
- irreconcilable differences between alternative methodologies
- the failure of team members to understand each other's disciplines or learn from each other
- problems in understanding what the other discipline practitioners actually do
- the need for each discipline to make undesirable compromises
- problems with understanding terminologies across disciplines
- entrenched philosophical positions

In conclusion, even though we have only examined a small sample of case studies<sup>10</sup>, there appear to be some quite serious obstacles to effective multidisciplinary practice by practitioner. In the next chapter, we will explore the possible underlying causes of such problems.

## 5. Summary

This introductory chapter has characterised requirements engineering, detailed a range of disciplinary contributions to the field, and illustrated and explored different types of multidisciplinary practice. Dependent multidisciplinary practice by practitioner was examined, and a number of problems with such practice were identified. The next chapter explores the possible underlying causes of such problems.

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<sup>10</sup> Because, as Kuutti (1993, 1994) notes, there is little published case study material about collaboration between different disciplines in system development. Furthermore, Gaska and Gause (1998) suggest that 'no specific work on multiple disciplines has focused on the RE phase.'



## Chapter Two

### Dependent Multidisciplinary Practice: The Problem with Paradigms

The first step to understanding... is the bringing to consciousness of the model or models that dominate and penetrate thought and action. Like all attempts to make men (sic) aware of the categories in which they think, it is a difficult and sometimes painful activity, likely to produce deeply disquieting results.

Isiah Berlin, 1962

#### 1. Introduction

This chapter explores the possible underlying causes of the problems in dependent multidisciplinary practice (both in general, and with particular emphasis on the problems of dependent multidisciplinary practice by practitioner) that were identified in Chapter 1.

This chapter proposes that in order to understand the roots of such problems, we need first to understand the nature of disciplines more generally. In this respect, the notion of a *paradigm* (Kuhn, 1962, 1970a; Burrell and Morgan, 1979; Guba and Lincoln, 1989, 1994) is used to guide reasoning about the nature of disciplines in terms of the types of problem they address, the practices they employ to address these problems, and the knowledge they possess that supports those practices (Dowell and Long, 1989).

It is argued that, in essence, paradigms can be understood as fundamentally different sets of assumptions about the nature of the world and how to obtain knowledge about it; and in this sense, paradigms can be thought of as the bedrock upon which disciplines are built.

Furthermore, it is suggested in this chapter, that a possible underlying cause of problems in dependent multidisciplinary practice is the fact that paradigms are philosophically **incommensurable**, where such incommensurability is taken to mean that paradigms have no common measure, and cannot be mixed together or synthesised (Jackson and Carter, 1991; Sankey, 1994).

Section 2 briefly considers the hierarchical nature of disciplines, and points to the concept of *paradigm* as a way to understand the characteristics of 'super-ordinate' disciplines. Section 3 explores the notion of paradigm from three different perspectives. Section 4 presents the case for the incommensurability of different paradigms, and examines the arguments for and against the practical accommodation of paradigms. Section 5 proposes that dependent multidisciplinary practice by practitioner may only be possible if we concede the possibility of the practical **accommodation** of alternative paradigms, and generates some requirements which, if met, would support the practical accommodation of paradigms. Section 6 introduces the idea of a dialectic approach to the practical accommodation of paradigms.



## 2. Disciplines and Paradigms

Long and Dowell (1989) suggest that most definitions of disciplines assume three primary characteristics: *knowledge*; *practice*; and a *general problem* with a particular scope.

Discipline knowledge is the product of research or a field of study. It may be public or private, and may take a number of forms (e.g. tacit, formal, codified, etc.). It may also be maintained in a number of ways including: journals; learning systems; or procedures and tools. A discipline's knowledge is used by its practices to solve a general (discipline) problem. For example, the discipline of science includes the scientific practice (e.g. experimentation) addressing the general (scientific) problem of explanation and prediction. For Long and Dowell (1989), then, disciplines are distinguished by the general discipline problem that they address. However, the scope of general (discipline) problems can also be decomposed, allowing the division of disciplines into sub-disciplines. For example, the scientific discipline includes the disciplines of physics, biology, psychology and so on, each of which is distinguished by some particular scope of the general problem of understanding that science addresses. The discipline of psychology, for example, addresses a general (scientific) problem whose particular scope is the understanding, explanation and prediction of the mental and physical behaviours of humans and animals. Similarly, the discipline of biology addresses a general problem whose particular scope includes understanding anatomy, physiology and so on.

The possibility of the division of a discipline into sub-disciplines is useful insofar as it allows us to classify disciplines and examine their commonalities and differences. Pursuing this possibility, the discipline of science can be thought of as a sub-discipline of a superordinate discipline whose scope might include metaphysical beliefs about the nature of the world, the human individual's place in it, and the range of possible relationships between human beings and the world. Such a superordinate discipline which addresses such sets of basic assumptions and beliefs is frequently known as a *paradigm* (Burrell and Morgan, 1979; Guba and Lincoln, 1989, 1994).

The next section examines the concept of paradigm in more detail.



### 3. Paradigm Perspectives

This section briefly presents three different, and influential, paradigm perspectives as proposed by: Kuhn (1962, 1970a); Burrell and Morgan (1979); and Guba and Lincoln (1989, 1994)<sup>11</sup>.

#### 3.1. Paradigms as a Disciplinary Matrix (Kuhn, 1962, 1970)

Kuhn's classic work, *The Structure of Scientific Revolutions* (Kuhn, 1962, 1970), is about the authority of science, and proposes that this authority lies not in a rule-based method of enquiry which obtains scientific results, but in the scientific community that obtains the results.

In the first edition of his book (1962), Kuhn frequently used the term paradigm, but its meaning was considered by many to be very variable - Masterman (1970), for example, identified twenty-one different uses of the term. In his postscript to the second edition of his book (1970), and in a discussion paper published in the same year (Kuhn, 1970b), Kuhn concurs with his critics, and distinguishes two fundamentally different senses of the term:

- 1) paradigms as a constellation of group commitments
- 2) paradigms as shared examples (exemplars)

These two senses of the term are then subsumed under the concept of a *disciplinary matrix* comprising:

- i) values
- ii) metaphysical beliefs
- iii) symbolic generalisations
- iv) exemplary past achievements

*Values* can be shared widely among different communities and are judgements about desirable properties of theories or parts of theories. Examples of such values are judgements about predictability, accuracy, simplicity, consistency, plausibility and so on. Kuhn believes that though values may be widely shared among scientists, and though commitment to them is both deep and constitutive of science, the application of values is sometimes considerably affected by the features of the individual applying them.

*Metaphysical beliefs* include shared commitments to certain convictions ranging from heuristics to ontological models which supply the group with preferred analogies and metaphors (a belief in atoms or fields of force, for example).

*Symbolic generalisations* (e.g.  $f=ma$ , "action equals reaction") are generally accepted by group members and function partly as laws and partly as definitions of their symbols. Kuhn

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<sup>11</sup> These three perspectives are not considered to be exhaustive, but are widely cited and representative.



proposes that the power of a science seems to increase with the number of such symbolic generalisations that its practitioners have at their disposal.

The fourth, and most important component of the disciplinary matrix, is *exemplary past achievements* or *exemplars*, that are concrete puzzle-solutions employed as models or examples.

Eckberg and Hill (1980) suggest that for Kuhn possession of a paradigm (particularly in the form of shared exemplars) locks its practitioners together in a fairly rigid, highly elaborated system of consensual beliefs within a self-contained community, and members of such a community see themselves as pursuing a set of shared goals, including the training of their successors. In this sense, paradigms in the Kuhnian sense are not shared by an entire discipline (e.g. biology), but more correctly by a specialised community (e.g. phage workers in biology). This restricted view of a scientific community explains why philosophers of science (e.g. Shapere, 1980; Gutting, 1980) generally agree that Kuhn's paradigms are in the main confined to the physical sciences and virtually by definition monopolistic, hegemonic and exclusive for a stretch of time (Martins, 1972).

The next section, by way of contrast, examines a somewhat broader perspective on the notion of paradigm, that of Burrell and Morgan (1979).

### **3.2. Paradigms as Meta-Theoretical Assumptions: Burrell and Morgan (1979)**

Burrell and Morgan (1979) in their influential book *Sociological Paradigms and Organisational Analysis* conceptualised the multiple paradigms of the social sciences in terms of the relationship between different views of the social world based upon different theoretical and philosophical assumptions with regard to the nature of social science and the nature of society. These basic assumptions underwrite the frame of reference, mode of theorising and *modus operandi* of the theorists and practitioners who operate within them.

Burrell and Morgan provide a classificatory framework comprising two dimensions:

- 1) A social science dimension consisting of four distinct but related assumptions about: *ontology*, *epistemology*, *human nature* and *methodology*.
- 2) A nature of society dimension that defines two alternative and fundamentally different approaches to society: *regulation* and *radical change*.

The two independent dimensions described above, are combined to form four mutually exclusive frames of reference which Burrell and Morgan call **paradigms** (see Figure 2.0).



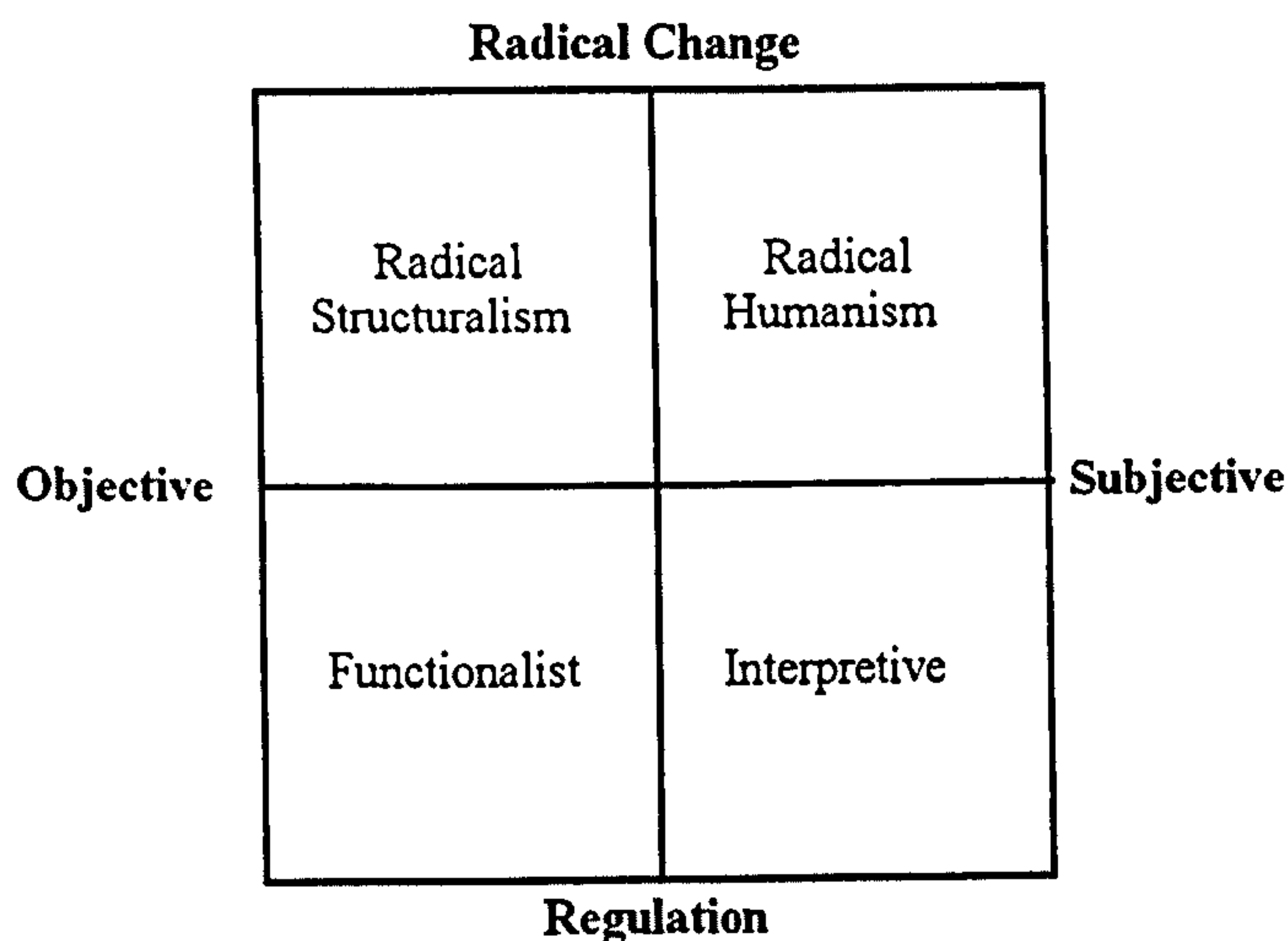


Figure 2.0: Four Mutually Exclusive Paradigms

Burrell and Morgan claim that in their work they are:

using the term “paradigm” in a broader sense than that intended by Kuhn...  
It is a term which is intended to emphasise the commonality of perspective  
which binds the work of a group of theorists together...

Burrell and Morgan consider that each paradigm will have an **underlying unity** in terms of its basic and taken-for-granted assumptions. This unity does not preclude different standpoints within a given paradigm, but does suggest that to be located in a particular paradigm is to view that world in a particular way.

The root of Burrell and Morgan’s argument is that they firmly believe that the importance of making explicit the opposing assumptions behind paradigms should not be underplayed. They believe that however close an individual’s position is to the middle ground, one must be committed to one side more than another. They further maintain that these distinctions present fundamentally different views and interpretations of the nature of society, reflect alternative frames of reference, provide alternative models for the analysis of social processes, and are consequently necessarily separate and distinct from each other.

Clearly, Burrell and Morgan’s work particularly addresses the social sciences and organisational studies, so what evidence do we have that it can be applied more widely?

First, the literature reveals that their framework has been successfully used as an explanatory tool in fields as varied as information systems development (Hirschheim, 1989); management information systems (Banville and Landry, 1989); management accounting (Hopper and Powell, 1985); hospital information systems (Symon et al, 1992), and agriculture (Holt and Schoorl, 1993).

Second, Burrell and Morgan themselves also have a view on the general applicability of their work, they say:

the scope for applying the analytical scheme to other fields of study is enormous...readers interested in applying the scheme should find little

difficulty in proceeding from the sociological analysis to an analysis of the literature in their own sphere of specialised interest.

The Burrell and Morgan framework has been very influential in the social and organisational sciences, but is not without its critics (e.g. Chua, 1989), and there have been considerable disagreements over its dimensions (in particular the regulation-radical change axis), and the form of its analysis (see Jackson and Carter, 1991).

The next section examines a paradigm perspective, that of Guba and Lincoln (1989, 1994), that employs the least controversial elements of the Burrell and Morgan framework in a more generally applicable framework.

### **3.3. Paradigms as Basic Belief Systems (Guba and Lincoln 1989, 1994)**

A recent perspective on the multi-paradigm nature of the social sciences is provided by Guba and Lincoln (1989, 1994). They consider that a paradigm may be viewed as set of **basic beliefs** that represent a worldview that defines for its holder the nature of the “world,” the individual’s place in it, and the range of possible relationships to that world and its parts. The beliefs are basic in that they must be accepted on faith (however well the beliefs are argued); there is no way to establish their ultimate truthfulness.

They define a paradigm as:

the basic belief system or worldview that guides the investigator, not only in choices of method but in ontologically and epistemologically fundamental ways.

The basic beliefs that define paradigms can be summarised by the way their proponents respond to three fundamental questions which are interconnected in such a way that the answer given to any one question, taken in any order, constrains how the others may be answered. These three questions (which are clearly a reduced and uncontroversial set of those asked by Burrell and Morgan, 1979) are:

- **The ontological question:** what is the form and nature of reality, and therefore, what knowledge can be about?
- **The epistemological question:** what is the relationship between the knower (the inquirer) and what can be known?
- **The methodological question:** how can the knower (the inquirer) go about finding out about whatever he or she believes can be known?

Guba and Lincoln (1994) believe that the order of these questions reflects a logical, if not necessary, primacy. They also argue that these questions can be answered in many different ways, and each different formulation is in effect a different paradigm. There is no way to answer these questions in a way that is capable of proof, so any paradigm simply represents the most informed and sophisticated view that its proponents have been able to devise, given



the way they have chosen to respond to the three questions. They further argue that the sets of answers given are in all cases human constructions; that is they are all inventions of the human mind and hence subject to human error. No construction can be incontrovertibly right, and advocates of any particular construction must, therefore, rely on its **persuasiveness** and **utility** rather than proof in arguing their position (see also Section 3.3).

Guba and Lincoln (1994) characterise four alternative paradigms: positivism; postpositivism; critical theory; and constructivism. These four paradigms are summarised in Table 2.0 which illustrates how each of the paradigms differ in their answers to the three ontological, epistemological and methodological questions.

	Positivism	Postpositivism	Critical Theory	Constructivism
Ontology	Realism	Modified Realism	Historical Realism	Relativist
Epistemology	Objective	Modified Objective	Subjective	Subjective
Methodology	Manipulative	Modified Manipulative	Transformative	Facilitative

Table 2.0: Basic Beliefs of Four Alternative Paradigms

In sum, then, Guba and Lincoln’s work is perhaps the most generally applicable of the three paradigm perspectives we have examined. Indeed, few people in any field (apart from some postmodernists, perhaps - see Section 4.3.1) would object to being asked to make clear their ontology, epistemology and methodology, and Guba and Lincoln (1994) suggest that:

the paradigms we describe can have meaning even in the realm of the physical sciences.

Because of its general applicability, the Guba and Lincoln perspective is used in Chapter 3 to select two different paradigms, and techniques representative of these two paradigms are then used to construct requirements for the redesign of an accident and emergency healthcare information system.

## 4. Discussion on the Accommodation of Paradigms

Despite their differences, all three of the paradigm perspectives previously outlined in this chapter share a common feature: they all believe that paradigms are philosophically **incommensurable**, where such incommensurability is taken to mean that paradigms have no common measure, and cannot be mixed together or synthesised (Jackson and Carter, 1991; Sankey, 1994).

Conversely, however, a re-occurring theme running through the literature on paradigms is a debate about whether it is possible to achieve some other kind of **accommodation** between paradigms at a *practical* level.

These related issues are discussed in detail below.

## 4.1. Incommensurability of Paradigms

The view that paradigms are distinct and cannot be mixed is based on the notion of irreconcilable conflicts between their philosophical positions on certain key features including: criteria; facts; meaning; and values (after Kitchener, 1986). Each of these features is considered in turn below.

*Criteria:* Competing paradigms often select different problems as the most important to solve, and employ different standards against which to judge the success of the solution. Incommensurability is typically taken to imply that there is no common measure among paradigms of inquiry; that is, rival paradigms cannot be comparatively evaluated by a neutral set of rules or criteria (Lincoln, 1990).

*Facts:* Rival paradigms do not share a common body of data that provides a neutral standard for their comparison; their fundamentally different theoretical viewpoints lead to different perceptions of the facts. That is, there are no neutral facts, free of all theory and empirically given, and all facts are consequently relative with respect to a particular paradigm. Similarly, the *content* of paradigms cannot be compared since they are logically and epistemologically incompatible (Feyerabend, 1970; Martins, 1972).

*Meaning:* Paradigms cannot be compared because there is no language or vocabulary available that is independent of theory. Languages categorise the world in different ways, and in the transition between paradigms words change their meanings or conditions of applicability in subtle ways (Kuhn, 1970a). Gioia and Pitre (1990), for example, believe that a paradigm's:

fundamental assumptions...purposes... goals for constructing theory...  
epistemic rhetorical bases and vocabulary used to communicate concepts...  
preclude any *bona fide* synthesis.

*Values:* Guba and Lincoln (1994) adopt an unashamedly relativistic position when they say that all paradigms are human constructions, that is products of the human mind and hence subject to human error. No construction, then, can be incontrovertibly right. For them:

the basic beliefs of paradigms are essentially contradictory... value  
freedom and value boundedness, cannot coexist in any internally consistent  
metaphysical system.



In summary, then, paradigms are incommensurable since the rules for action, for process, for discourse, for what is considered knowledge and truth, are different and lead to diverse, disparate, distinctive and typically antithetical ends (Lincoln, 1990; Gioia and Pitre, 1990).

Despite accepting the philosophical incommensurability of paradigms, a number of authors have suggested that it may be possible to **accommodate** different paradigms within the multi-disciplinary **practice** within a given field (e.g. Weaver and Gioia, 1995 with respect to organisational studies; Chua, 1986 with respect to accountancy). Such practical accommodation might take place either through the collaborative work of groups of practitioners holding different paradigms, or via the practice of individuals<sup>12</sup>. These two types of accommodation are discussed below under the headings of **social-community** accommodation and **individual** accommodation (after Skrtic, 1990).

## 4.2. Social-Community Accommodation of Paradigms

The implication from the arguments outlined in Section 3 is that a scientific community is premised on meta-theoretical assumptions, defined by a paradigm. Without a paradigm acting explicitly or implicitly as a way of seeing, there can be no scientific community (Barnes, 1982; Ravetz, 1971; Skrtic, 1990).

This said, we still might ask whether advocates of alternative paradigms can live with (and learn from) each other even though they are based in different paradigms? (after Austin, 1990).

The emphasis, then, when considering the social-community accommodation of paradigms, is on communication between different schools of thought. Accommodation in this sense involves understanding the key issues of each paradigm, appreciating the views of those operating in a different paradigms, and allowing multiple contributions to the same inquiry (constructing requirements for the redesign of an information system, for example).

However, this type of accommodation is not without its dangers, both for the practitioners involved and the paradigms they work within. The first danger is that social-community accommodation may be *more apparent than real*. Multi-disciplinary teams, for example, are often proposed as ways to provide different perspectives on a problem. The differences between their respective approaches is used to produce an impression of a wide range and diversity of points of view. However, these apparently different theorists may be located within the same paradigm even if they do not share identical perspectives (Burrell and Morgan, 1979, suggest that socio-technical theory, for example, still operates within a traditional functionalist paradigm, despite its social perspective). Multi-disciplinary teams, therefore, do not always give as all-round a view as is sometimes thought.

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<sup>12</sup> Note that both of these types of accommodation would be required to support dependent multidisciplinary practice by practitioner.



The second danger is that of *incorporation*. There is sometimes a tendency for alternative paradigms to be regarded as simply points of view which need to be considered, and if possible, rebuffed or incorporated within the dominant orthodoxy. Such a view favours fusion and incorporation as the natural line of intellectual development. Burrell and Morgan (1979), for example, have illustrated how, in relation to the historical development of the functionalist paradigm, various elements of idealism and Marxist theory have been incorporated in this way. Whilst strengthening the functionalist perspective, this fusion has by no means done full justice to the respective paradigms from which these elements derive. Indeed, it has been at the cost of their complete emasculation and a misunderstanding of their very nature. Consequently, Burrell and Morgan argue for paradigmatic closure on the basis that an alternative paradigm can only establish itself, if it is true to itself.

The third danger is that non-dominant paradigms may be forced to take up the role of *handmaiden* to the dominant paradigm (Guba and Lincoln, 1989). This situation is where a alternative paradigm is used to make good the deficiencies of the dominant paradigm without calling that paradigm into question. An ethnomethodological approach to inquiry, for example, may be tacked onto a conventional software development process to unearth social issues of interest that can be passed onto the software engineer to inform the “real design work.”

Despite these dangers, the social-community accommodation of paradigms is the focus of much recent multi-disciplinary work in requirements engineering. Macaulay (1996), for example, proposes to improve the communication process between different disciplines in the early phases of information systems design, and Sommerville (1995) proposes to extend the notion of “viewpoints”, since each participant in the process may have a different notion of requirements engineering and developing a common model can be very difficult. There are also a number of requirements methods which attempt to integrate methods from different paradigms (e.g.: MULTIVIEW, Wood-Harper et al, 1985; MEASUR, Stamper, 1994; FAOR, Schäfer et al, 1988; SSADM, Downs et al, 1992; ORDIT, Dobson et al, 1994; RACE, Bustard et al, 1995, 1996). It is probably worth pointing out that all of the methods cited above attempt to integrate a social/organisational perspective (such as Checkland’s, 1981, 1990, soft systems methodology) with a software engineering perspective (such as JSD or Object Oriented Analysis).

Finally, although for social-community accommodation it is not necessary for each individual researcher to be able to operate within different paradigms, it is essential that each researcher should appreciate other views from alternative paradigms. However, the individuals involved may not be able to even reach this level of appreciation. For example, Patton (1975) said that paradigms:

are deeply embedded in the socialisation of adherents and practitioners telling them what is important, what is legitimate, what is reasonable.



The depth of the socialisation processes associated with each paradigm leads to a fourth danger insofar as each paradigm may be sufficiently divergent, and the emotional and political commitments so high, that to bring the two camps together, within either research or practice, may produce little more than *dissonance* and *incoherence* (Lincoln, 1990).

In sum, then, we might conclude that the social-community accommodation of paradigms, and hence communication between different schools of thought, may be possible (and indeed desirable), but has a number of dangers that need to be appreciated, and avoided, for such communication to be successful.

The next section examines the possibility of the individual accommodation of paradigms.

### 4.3. Individual Accommodation of Paradigms

A further implication from the arguments outlined in Sections 4.1 and 4.2 above is that the socialisation of individuals into accepting the assumptions of a particular paradigm, might lead to a fundamental separation of people operating in one paradigm from those operating in another paradigm. That is, paradigms and their communities may constrain the behaviour and beliefs of their individual members. Such constraints may lead individuals, who have (at best) only limited exposure to alternative perspectives to conclude that the way they have been taught is the *only* way to think and operate (Le Compte, 1990). Representatives of different paradigms, then, may live in different worlds (Kuhn, 1970a), hold mutually exclusive beliefs (Burrell and Morgan, 1979), use different vocabularies (Jackson and Carter, 1991) and have different ways of seeing (Gioia, Donnellon and Sims, 1989). Despite such differences, however, we might still ask whether “an individual researcher or practitioner can accommodate various paradigms?” (after Austin, 1990).

Firestone (1990) believes that whether paradigms can be accommodated depends on one's stance on the nature of paradigms and the philosophical principles and research practice. He considers that those who argue that paradigms are incompatible view them as systems of rules that are largely deductive; where assumptions about the nature of the world (ontology), and how one knows it (epistemology), govern the conduct of the research. Firestone suggests an alternative conception of paradigm that views the paradigm-practice relationship as bi-directional, rather than uni-directional, and suggests that in practice researchers use a variety of imperfect approaches to enhance the credibility of their arguments.

In short, Firestone believes that an accommodation of paradigms is possible at the level of the individual, and argues that individuals should let the various paradigms inform practice to the extent that they are useful. According to this approach, the methods that characterise the various paradigms can be combined by the individual to solve particular problems and answer particular questions. For example, with respect to requirements engineering, Macaulay (1996) has suggested that a requirements engineer might develop a

large portfolio of requirements techniques which can be drawn upon depending on the given situation, and used in combination as required.

Although Firestone's bi-directional understanding of the development and use of paradigms opens up the possibility of personal accommodation, the danger with his position is that few practitioners will consciously articulate the paradigms from which they are borrowing techniques, and by not doing so they are unlikely to understand the implications of using such techniques. Practitioners of this type will be content to live with any number of internal inconsistencies that they neither recognise nor even particularly value within their context and priorities (Crandall, 1990).

Individual accommodation of paradigms, then, requires (at the very least) that the role of the paradigm be brought into the realm of conscious thought. Schön (1983) in his influential book *The Reflective Practitioner* suggests that such a conscious use of paradigms may be a difficult, but not an impossible task. He says:

when a practitioner becomes aware of his (sic) frames, he also becomes aware of the possibility of alternative ways of framing the reality of his practice. He takes note of the values and norms to which he has given priority, and those he has given less importance, or left out of the account altogether. Frame awareness tends to entrain awareness of the dilemmas...inherent in professional pluralism.

Given a sufficient understanding of alternative paradigms, then, it may be possible for an individual to behave in a fashion congruent with selected paradigms. This notion is supported by Burrell and Morgan (1979), who say:

one can operate in different paradigms sequentially over time, but... one cannot operate in more than one paradigm at any given point in time, since in accepting the assumptions of one, we defy the assumptions of all the other.

This view is also supported by Kuhn (1970a). In his first edition of *The Structure of Scientific Revolutions*, Kuhn described the adoption of a new paradigm as a conversion experience which cannot be forced and which occurs all at once like a *gestalt* switch. Critics of Kuhn (e.g. Shapere, 1980) argue that this switch signifies an irrational leap-of-faith. In his postscript to the second edition, Kuhn argues that one can be persuaded to adopt a theory without being converted to it. He believes that the distinction between **persuasion** and **conversion** is an important one which allows communication between proponents of rival paradigms, since **translation** is difficult but not impossible.

Translation is difficult because languages categorise the world in different ways which we have no neutral means of reporting, but it does offer the possibility of communication between advocates of alternative paradigms. However, in the absence of a neutral language, the choice of an alternative paradigm is an individual decision to adopt a different language and deploy it in a correspondingly different world. This view allows Kuhn to retain some



vestiges of his idea of conversion, for a person can go beyond translation to the actual adoption of a new language which he thinks and speaks (Barbour, 1980).

Similarly, Lincoln (1990) believes that learning to use and possibly adopting a new paradigm is an intensely personal process, evolving not only from intellectual, but also personal, social and possibly political transformations. In line with this view, Reinharz (1981) has developed a model of the process by which individuals develop a commitment and ability to operate within a different paradigm (see Figure 2.1 below).

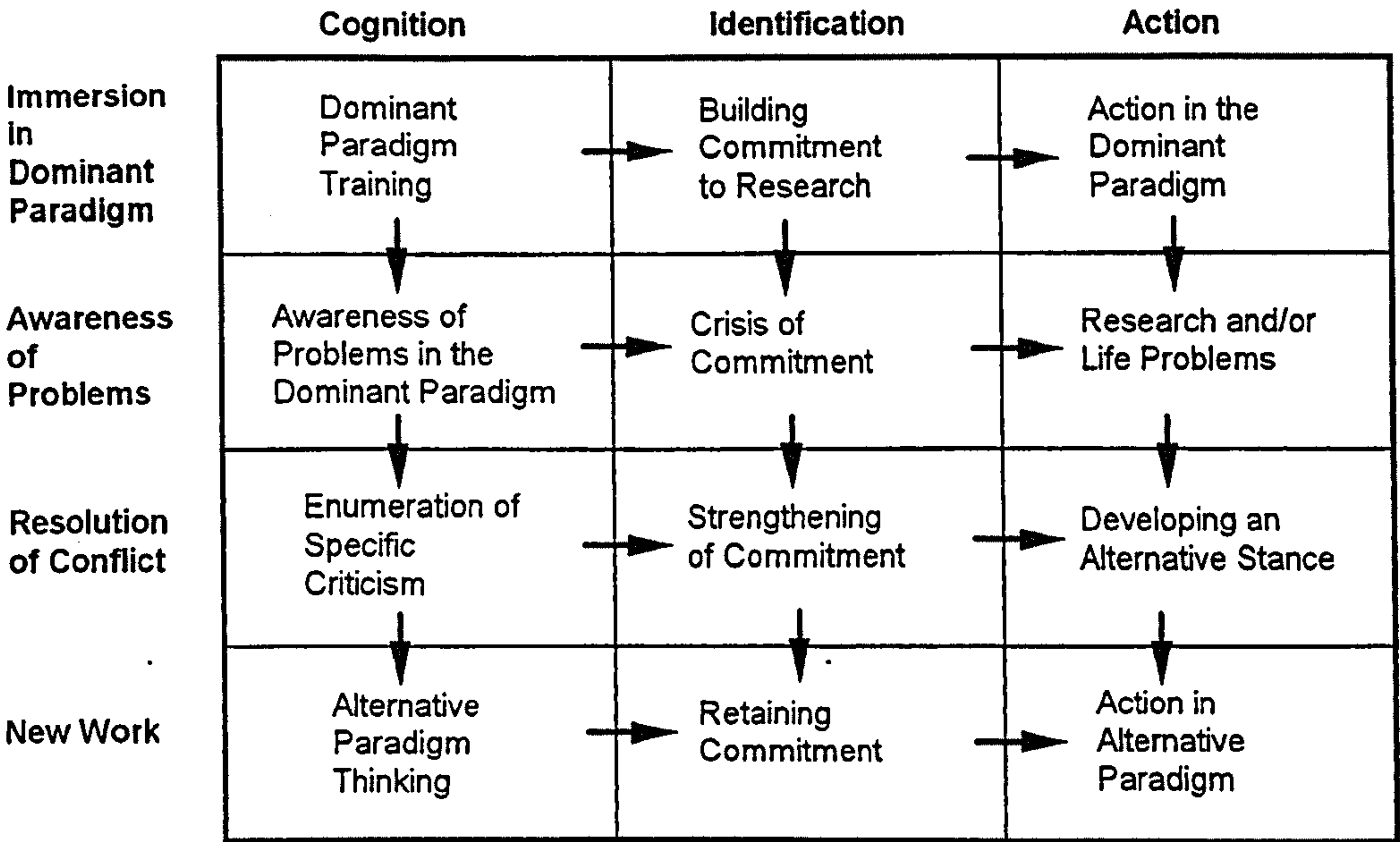


Figure 2.1: Developing an Alternative Paradigm Perspective  
(amended from Reinharz, 1981)

In line with our previous arguments, this model need not be read as a requiring the abandonment of the paradigm which previously dominated earlier thinking. However, it does point to the fact that for practitioners intending to operate in more than one paradigm it is important to manage commitment and critical reflection. For Barbour (1980), commitment alone without reflection tends to become narrow dogmatism, and reflection alone without commitment tends to become pure speculation; and it is precisely the combination of commitment and reflection that constitutes individual and community maturity (Barbour, 1980). Similarly, Guba and Lincoln (1994) believe that:

paradigm issues are crucial; no inquirer ought to go about the business of inquiry without being clear about what paradigm informs or guides his or her approach.

In sum, we might conclude that individuals may be able to operate in more than one paradigm; but that such practical accommodation can only take place sequentially over time, either by conversion or by critical reflection.

### 4.3.1. Postmodernism and the Postparadigmatic Diaspora

We cannot leave a discussion on paradigms without briefly considering the postmodern alternative (especially since a postmodern perspective is receiving considerable attention with the field of requirements engineering - see Bickerton and Siddiqi, 1993).

The term postmodernism is used to describe the response to the perceived failures of the preceding modern period (Legge, 1994), and in the current context directly attacks the very notion of paradigms.

Postmodernism is generally identified with the critical tradition, and seeks question the basis of rationality, using insights into the immanence of power in language (e.g. Lyotard, 1984). Postmodernism typically calls for a pluralistic approach to the production of knowledge, and seeks to remove the rationale for paradigms by seeking to dissolve the need for paradigm boundaries. Caputo (1987), for example, coined the term “post-paradigmatic diaspora” to capture a postmodern exhaustion with a paradigmatic style of discourse. Postmodernism takes the view that paradigms put order into an untidy universe, but to demand that all inquiry decisions be in line with a worldview embodied in a paradigm is problematic. Postmodernism, then, is characterised by a new sensibility that doubts all previous paradigms and leads to calls for a pluralistic approach to the production of knowledge (e.g. Reed, 1988; Foucault, 1971).

However, such appeals to pluralism do not provide protection against the incorporation of alternative viewpoints into the dominant orthodoxy (a problem identified above as important to the notion of dependent multidisciplinary practice). From the perspective of this thesis, pluralism is likely to lead to outcomes that are determined by those with most power (or by consent of the majority). In contrast, the recognition of paradigm incommensurability actually provides a defence for radical perspectives against the encroachments of orthodoxy (see also Jackson and Carter, 1991).

This position echoes the views of Marcus (1994), who believes that the power of the postmodern intervention lies in critiquing and extending existing paradigms rather than in setting a new post-paradigm agenda. Thus, for example, feminists and ethnic researchers have articulated their own relationship to existing paradigms, and these new articulations have served to refocus and redefine previous ontologies, epistemologies and methodologies including positivism and post-positivism (Lincoln and Denzin, 1994a, 1994b). Similarly, Morgan (1993) believes that postmodernism’s critical stance has done much to help us understand how biases and blind spots can accompany and sometimes dominate ways of seeing (paradigms).

In sum, then, for the purposes of this thesis, we will concur with Marcus that the contribution of postmodernism is in its power of critique rather than in its overthrow of the paradigmatic style of discourse.



# 5. Accommodation of Paradigms and Dependent Multidisciplinary Practice in Requirements Engineering

In Chapter 1, we have explored the general notion of dependent multidisciplinary practice in requirements engineering, and have highlighted in particular a number of problems with dependent multidisciplinary practice by practitioner. For convenience, these problems are shown again in Table 2.1 below:

<ul style="list-style-type: none"><li>• dichotomy of approach between the two disciplines</li><li>• problems of viewpoint, and the different interests that the disciplines take in the world</li><li>• lack of shared assumptions (about the system development process)</li><li>• irreconcilable differences between alternative methodologies</li><li>• the failure of team members to understand each other's disciplines or learn from each other</li><li>• problems in understanding what the other discipline practitioners actually do</li><li>• the need for each discipline to make undesirable compromises</li><li>• problems with understanding terminologies across disciplines</li><li>• entrenched philosophical positions</li></ul>
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Table 2.1: Problems associated with dependent multidisciplinary practice by practitioner

In this chapter, we have argued that the root cause of such problems lies in the fact that paradigms are philosophically incommensurable.

In the light of these two arguments, we might propose that dependent multidisciplinary practice by practitioner relies upon the practical accommodation of alternative paradigms. That is, overcoming the problems of dependent multidisciplinary practice by practitioner relies upon: communication between different 'schools of thought' (i.e. social community accommodation); and the need for individual practitioners to consciously articulate, reflect upon, and perhaps even operate within, alternative paradigms (i.e. individual accommodation).

In the remainder of this thesis, we aim to develop an approach that can help overcome the problems of multidisciplinary practice by practitioner by supporting the practical accommodation of paradigms.

To support the development and assessment of the approach, we have condensed the discussions of this chapter into a set of *criteria* which, if met, would support the practical accommodation of paradigms<sup>13</sup>. These criteria are summarised in Table 2.2 below:

<sup>13</sup> These criteria are not considered to be exhaustive.

**A. Criteria for the social-community accommodation of paradigms**

Any approach that aims to support the practical accommodation of paradigms should:

- 1) Support multiparadigmatic contributions to the same inquiry (Austin, 1990).
- 2) Help practitioners understand the key issues of each paradigm (Crandall, 1990)
- 3) Help practitioners appreciate the views of those operating in a different paradigm (Austin, 1990).
- 4) Allow each paradigm to express itself independently of the other (Burrell and Morgan, 1979).
- 5) Help improve communication between practitioners of different paradigms (Guba and Lincoln, 1989)
- 6) Help practitioners understand the practical implications of alternative paradigm positions (Skrtic, 1990).
- 7) Help practitioners understand alternative beliefs (Burrell and Morgan, 1979).
- 8) Help practitioners understand the values and norms of alternative paradigms (Schön, 1983).

**B. Criteria for the individual accommodation of paradigms**

Any approach that aims to support the practical accommodation of paradigms should:

- 9) Bring the role of the paradigm into the realm of conscious thought (Schön, 1983).
- 10) Support practitioners in the conscious articulation of alternative paradigm positions (Crandall, 1990)
- 11) Help practitioners change their own behaviour and beliefs (Le Compte, 1990).
- 12) Help practitioners use different vocabularies (Barbour, 1980; Jackson and Carter, 1991)
- 13) Support practitioners in the enumeration of specific paradigm positions and criticisms (Reinharz, 1981).
- 14) Support practitioners in the management of commitment and critical reflection (Reinharz, 1981).

Table 2.2: Criteria for an approach to support the practical accommodation of paradigms

The next section introduces an approach, which it is envisaged, can meet these criteria. The approach is considered in detail in Chapter 3. The criteria are employed later in the assessment of the approach (see Chapter 8).



## 6. Towards a Dialectic Approach to the Accommodation of Paradigms

In the next chapter, it is proposed that a **dialectic** approach may have the potential to support the accommodation of paradigms, and meet the requirements outlined in Table 2.2.

It is suggested that a dialectic approach is suitable in this context insofar as dialectic reasoning has long been used to examine divergent and contradictory perspectives with a view to achieving a higher level understanding of them all (Plato, Aristotle, Hegel, Darwin, Marx, Nietzsche and Freud, for example, can all be thought of as dialectic thinkers). The central idea of dialectic reasoning is that by putting forward a perspective and then contradicting it, the end result will be a more complex understanding of the original perspective (Astley and Van de Ven, 1983; Guba and Lincoln, 1989). For the purposes of this thesis, this type of thinking might allow us to support the accommodation of paradigms and hence support dependent multidisciplinary practice.

In the next chapter, then, we will develop a dialectic approach that it is claimed can support dependent multidisciplinary practice by practitioner in requirements engineering.

## Chapter Three

# Dialectic Approach to Supporting Dependent Multidisciplinary Practice by Practitioner

You have to learn to think and feel against yourself.

George Steiner (1996)

### 1. Introduction

In Chapter 2, we suggested that overcoming the problems associated with dependent multidisciplinary practice by practitioner depends upon the practical accommodation of paradigms. Two types of accommodation were identified: social-community accommodation and individual accommodation. We also proposed that a dialectic approach may have the potential to support these two types of accommodation. This chapter develops such a dialectic approach.

Specifically, in this chapter, we develop a dialectic process which we then operationalise using a framework for argumentation that supports reasoning about the influence of the outputs of one paradigm/discipline upon another (in the context of requirements engineering).

We then illustrate how the dialectic process allows us to reason about the mutual influence of two requirements engineering techniques (one from the discipline of human factors, and one from the discipline of sociology; representing the post-positivist and constructivist paradigms respectively). A more detailed demonstration of the feasibility of these ideas is provided in Chapter 7.

The aim of this chapter, then, is to provide a 'first pass' at developing a dialectic approach that can support multidisciplinary practice by practitioner by supporting the practical accommodation of paradigms. The dialectic approach is applied in Chapter 7, and assessed and re-developed in Chapter 8.

Section 2 introduces briefly a number of concepts associated with dialectic reasoning, whilst Section 3 reviews previous literature in the area and considers the benefits and limitations of a dialectic approach. Section 4 develops a specific conceptualisation of the dialectic process to be used in this thesis, and Section 5 operationalises this conceptualisation, using a framework for describing and analysing arguments. Section 6 shows how we can use the dialectic process and the framework to support multidisciplinary practice by practitioner in the field of requirements engineering.



## 2. Brief Introduction to Dialectic Reasoning

This section introduces the basic concepts and ideas associated with dialectic reasoning.

Dialectic reasoning is an ancient form of thinking which deals with contradiction. The term dialectic is derived from the Greek *dialectike*, meaning roughly the art of conversation or discussion - more literally meaning reasoning by splitting into two. In its most general sense, however, dialectic reasoning has come to signify a process which analyses conceptual, social (and even natural) conflicts and contradictions with the aim of transcending them (Bhaskar, 1993, 1994).

The contradictions which are at the heart of dialectic reasoning are often taken as an indication that an existing conceptual field is incomplete in some relevant respect. For example, if we consider a thesis (A) and its antithesis (-A). The contradiction between (A) and (-A) becomes a device for the expansion of the previous conceptual field. In the expanded field, (A) and (-A) remain distinct, yet they are inseparable elements of a resolution (B) which transcends them (Rowan and Reason, 1981; Bhaskar, 1994). Over time, this resolution can become the new thesis, and the dialectic process recycles and continues. By its very nature, the resolution is something created, new, discontinuous with both thesis and antithesis (Levins and Lewontin, 1985; Van de Ven, 1994). A dialectic in this sense, then, can be characterised as a process that attempts to pull together contradictory elements into a resolution which includes the contradiction. In sum, dialectic reasoning can be understood broadly as a move from incompleteness through contradiction to greater totality.

In the next section, we will we will review dialectic reasoning as evidenced by previous work (largely in the field of organisational decision-making). We use this review to provide support for the notion that dialectic reasoning may be a suitable vehicle to support the accommodation of alternative paradigms, and hence support dependent multidisciplinary practice.

## 3. Dialectic Reasoning in Organisational Decision Making

This section reviews previous literature on a specific form of dialectic reasoning called *dialectical inquiry* (DI), that has been applied in the field of organisational decision-making (and more particularly economic planning).

The aim of this review is to illustrate how dialectic reasoning has proved to be successful in making explicit the assumptions underlying conflicting positions, and in some circumstances has also shown potential as a means to resolve such conflicts.

Since the mid 1960s, a number of attempts have been made to apply Hegel's dialectic to problem solving activities (particularly organisational problem solving). Much of this interest has been generated by Churchman's exploration of philosophically-based information

systems (summarised in Churchman, 1971). Churchman proposed that what we know about a problem is a direct function of how we have obtained that knowledge (i.e. of some system of inquiry). He outlined five types of inquiring system (IS) after five major philosophers in the history of Western epistemology: the Leibnizian IS; the Lockean IS; the Kantian IS; the Hegelian IS; and the Singerian IS.

To briefly summarise these distinctions: the Leibnizian IS emphasises the mathematical, the logical and the rational aspects of knowledge; the Lockean IS emphasises the purely sensory, empirical aspects of knowledge; the Kantian IS includes both formal and experiential aspects of knowledge; the Hegelian IS emphasises the antagonistic and the conflictual aspects of knowledge; and the Singerian IS brings together diverse types of knowledge including the scientific, the ethical and the aesthetic.

Churchman's work has probably had most impact in the field of organisational decision making. Mason (1969), for example, took up the idea of an Hegelian IS (first proposed by Churchman in a technical report in 1966). Mason suggested that a dialectic approach to decision making involved examining an organisational problem from two opposing points of view, using a structured debate which consists of a forceful presentation of two opposing plans. Mason termed this process *dialectical inquiry* (DI). He investigated the effects of DI on strategic economic planning in a manufacturing company, and concluded that the managers who used the technique formed a new more encompassing conceptualisation of the strategic planning problem (leading them to adopt a policy that they had not originally considered). Mason's work was extended by Mitroff (1971) who developed a mathematical model of DI based on probability theory.

Mitroff et al (1977) used DI with a planning problem in a large US federal agency. A lecture on DI was given to a group of 120 employees at the Bureau of Census. A total of 45 employees agreed to participate in the next phase of the study, and were clustered into five groups each of which produced a planning report suggesting future directions for the Bureau. Representatives of these five groups then formed an executive group that produced a final integrative report. Mitroff et al concluded that this final report contained several issues and alternatives which the participants found innovative and exciting.

Similarly, Mitroff et al (1979) used DI with a pricing decision in a drugs company. Three groups of managers, each advocating a different pricing policy, used DI to examine their divergent assumptions and arrive at a final policy. The authors reported that DI produced more and better alternatives and led to a different pricing policy than would have been chosen if DI had not been used.

Mason and Mitroff (1981) subsequently combined their earlier efforts into a technique for bringing out the underlying assumptions of any policy decision. This technique, the strategic assumption surfacing technique, incorporated dialectic debate procedures and a theory of argumentation which included a mathematical formulation of Toulmin's (1958) classic



model of argumentation. This thesis builds on the work on Mason and Mitroff in its use of an extended and enhanced formulation of the Toulmin model (see Section 5).

Cosier (1978) argued that the case studies of Mason (1969) and Mitroff (1977) did not demonstrate that the DI approach leads to an improvement in objective performance or more effective outcomes, because the large number of uncontrolled interacting variables made it difficult to assess the effect of one factor. They also argued that many of Mason and Mitroff's conclusions used the self-reports of the participants to infer positive effects, and as such were subject to confounding factors, such as the "Hawthorne Effect" (where the participants' enthusiasm is related to their very involvement in the project) or a "demand effect" (a desire to confirm the investigators' expectations). To support these criticisms, Cosier and his colleagues performed two laboratory studies which examined the effects of DI on performance and participant attitudes in business planning tasks. They concluded that although the conflict component of DI seems valuable, the best means of presenting that conflict may be in an alternative technique termed the *devil's advocate* technique (DA). DA uses a single interpretation of the data and a critique of that interpretation that suggests no alternatives (in contrast to the conflict between opposing positions as used in DI).

As a result of these criticisms, a number of other studies looked at the use of different types of conflict in controlled laboratory situations, using volunteer subjects. These studies did not attempt to capture the full complexity of DI as used in the field, but instead focused on comparative studies of DI and DA. Typically these studies involved the presentation of a plan and a critique to all DA subjects, and a plan and a counter-plan to all DI subjects.

For example, Cosier and Aplin (1980) examined the effect of DI and DA on a strategy formulation task. Subjects were given a document outlining case data, and asked to develop a planning document on the basis of these data. Subjects were assigned to one of four categories. The control group (C) received only the case data; an expert group (E) received the case data and an expert's report; the DA group received the case data, the expert's report and a critique of that report; the DI group received the case data, the expert's report and a counter-report based on different analysis and assumptions. The planners recommendations were evaluated by a panel of judges. The evaluation of the recommendations generated by the DA planners were rated higher than those generated by the DI planners on all of a standard set of evaluation criteria employed by the judges.

Similarly, Schwenk (1984a) investigated the effects of DI and DA on the generation of strategic alternatives. He found that DA led to the generation of more alternatives than DI. He also found that DA was more effective than DI at reducing the effect of an expert's report on the decision maker's final recommendation. Other laboratory studies which involved subjects in a number strategic prediction tasks (Cosier, 1978), or predictive financial simulations (Schwenk and Cosier, 1980), also generally favoured DA over DI.

Field researchers objected to these criticisms from the laboratory on a number of grounds. First, they noted that the process of dialectic reasoning is unfamiliar to most subjects and needs careful explanation before they attempt to use it. Second, they insisted that DI is not meant for use with disinterested subjects but with active, interested decision makers with real problems to tackle.

These criticisms were subsequently shown to carry some weight. Two laboratory studies which introduced the concepts of dialectic reasoning to those with a high commitment to performing the task well did indeed seem to favour DI over DA.

For example, Schweiger et al (1988) used a controlled laboratory experiment to assess the comparative effectiveness of DI, DA and a consensus approach in a group context (students who were being assessed as part of an obligatory course component). In general, their results suggested that conflict is useful in improving the quality of strategic decisions. In particular, both DI and DA led to higher quality recommendations and assumptions than the consensus approach. DI was also more effective than DA with respect to the quality of the assumptions brought to the surface, but there were no differences between DI and DA with respect to the quality of the recommendations. This last point has also been confirmed by recent studies using interactive computer-based support for DI, DA and consensus group decision-making (Tung and Heminger, 1993).

Schwenk (1984b) also repeated some of his earlier financial predictive tasks with more highly motivated subjects (again students being examined). Subjects were also assessed and rated as to their degree of commitment and task involvement. Schwenk devised two conditions of DI (one with additional explanatory instructions about how to use the technique {DI+} and one without any such instruction {DI}). The results indicated that whilst DI+ was not shown to be more effective than DI, the degree of task involvement was crucial to the subject's performance. On the basis of his results, Schwenk admitted that the claims of the field researchers, regarding the limitations of past laboratory work, did have some credence, and suggested that DI may be more effective than DA in real-world organisational decision-making.

In sum, there seems to be reasonable evidence that dialectic reasoning (as represented in this instance by DI) supports the identification of, and reasoning about, the assumptions underlying opposing positions. There is also somewhat more limited evidence that it may also be useful in improving the quality of strategic decision-making. On this basis, it seems reasonable to suggest that dialectic reasoning might have a potential role to play in supporting the practical accommodation of alternative paradigms (at least insofar as such accommodation relies upon communication between different 'schools of thought' and the conscious articulation of, and reflection on, alternative paradigm positions - see Chapter 2). This suggestion is explored in more detail in the remainder of this chapter.



## 4. Specific Conceptualisation of the Dialectic Process and Its Products

The studies mentioned in Section 3, do not employ a specific conceptualisation of the dialectic process and its associated products. This section develops such a conceptualisation, and then Section 5 operationalises this conceptualisation in the form of a framework within which to model (that is to describe and analyse) argumentative reasoning (of the sort required by the dialectic process). Section 6 argues that this conceptualisation and its operationalisation can provide support for the accommodation of alternative paradigms.

Much contemporary discussion of the dialectic approach revolves around the figure of Hegel, and his two treatises *The Phenomenology of Spirit* and *The Science of Logic*.

The *Phenomenology* might be crudely summarised as proposing that no philosophical viewpoint or conceptual framework, no matter how persuasive, can ever be adequate by itself. For every premise or set of premises, there is a context and a set of presuppositions that has been taken for granted; for every argument there is a perspective that has not been challenged; for every ethical argument there is a social, cultural and historical context that renders it intelligible. Hegel reminds us that all our principles and arguments and methods and schools and movements are abstractions within a larger context, and only make sense within that context. He reminds us always of our limited vision, our unexposed presuppositions, and our unwillingness to see the other side until forced (Solomon, 1983).

In the *Logic*, the dialectic is understood as a method for expounding fundamental categories, including forms of judgement and argument as well as fundamental concepts (Forster, 1993). The dialectic method was a process which remedied one-sidedness and incompleteness in arguments, and resulted in the reconciliation of contradictions. The dialectic process progresses in two ways: first, by bringing out what is implicit, but not explicitly articulated in some notion; and second, by repairing some inadequacy in it.

Figure 3.0 provides a specific conceptualisation of the dialectic process and its associated products<sup>14</sup>. In the figure, processes are represented by labelled arrows, and products are represented by boxes.

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<sup>14</sup> The specific conceptualisation is the author's consolidation of some of the literature on the Hegelian dialectic process, including: Solomon (1983); Forster (1993); Bhaskar (1994);

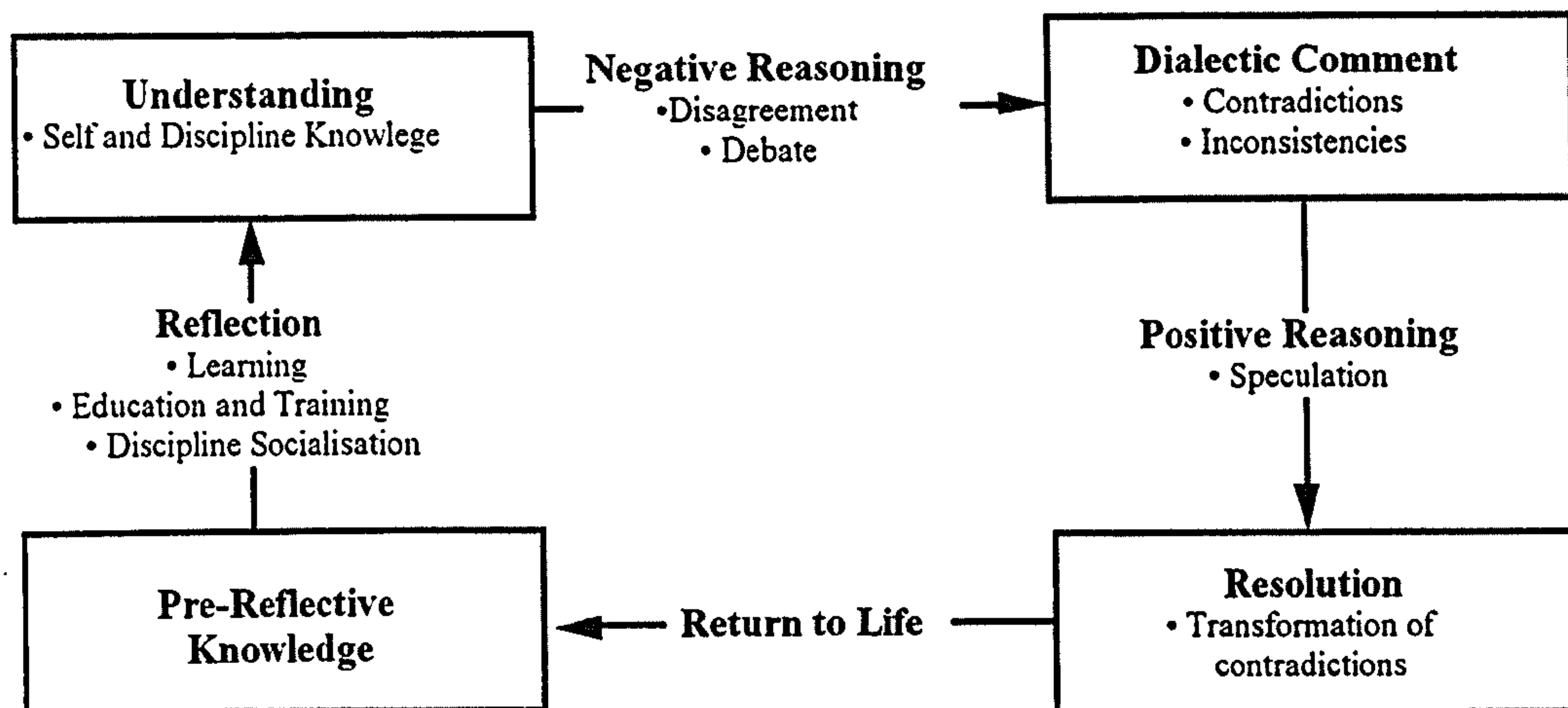


Figure 3.0: Specific Conceptualisation of the Dialectic Process and its Products

The component parts of the dialectic process and its associated products are considered below.

**Pre-reflective knowledge** - Hegel conceived of the pre-reflective reasonableness of ordinary life which readily tolerates contradictions without finding anything problematic in them (see also Chapter 2 Section 3.3). This state of being can be transformed by a process of **reflection** which includes the development of self knowledge and discipline knowledge through learning, education and training, and discipline socialisation leading to a more informed state known as **understanding**.

Understanding is the state in which an individual can take part in the theory and practice which characterise his or her discipline. Understanding in this sense might be thought of as a position from which one can engage in normal science (in the Kuhnian sense). However, if we stay at the level of understanding, we will not find or recognise contradictions in our concepts (beliefs/theory) or experience (practice), and to move beyond this stage takes considerable effort via the process of **negative reason**.

Negative reasoning stretches our concepts to the limit by forcing contradictions out of them and pressing contradictions upon them (Bhaskar, 1994). Negative reasoning is characterised by the construction of the strongest possible debate or disagreement on a given issue (Mitroff, 1970). The end point of the process of negative reasoning results in a **dialectic comment** on the practice of the pre-existing community which reveals and exposes its inadequacies and inconsistencies. In Kuhnian terms, a dialectic comment might have parallels with the epoch of scientific revolution. In dialectic reasoning, the dialectic comment is the actual or notional moment which mediates between the negative reasoning and **positive reasoning**.

Positive reasoning can be characterised as creative speculation that leads to the expansion of the existing conceptual field. If reflection is the act of reflecting on our own subjective views or interests, speculation is the act of attempting to free oneself from these biases in



order to work through the conflicting elements identified in negative reasoning (Hodgson, 1993). Expansion of the existing conceptual field (or world view) through positive reasoning results in the transformation of contradictions that leads ultimately to a **resolution** of the conflict (Cosier et al, 1978).

Resolution is characterised by the incorporation of contradictions into a fuller, richer, more comprehensive understanding; and is followed by a ‘return to life’. This return to life takes us to a new starting position from which the dialectic process can begin again.

In this thesis, we will be concerned primarily with the three processes of reflection, negative reasoning, and positive reasoning, and their respective products. The processes and products of concern here are shown in Table 3.0.

Process	Product
Reflection	Understanding
Negative Reasoning	Dialectic Comment
Positive Reasoning	Resolution

Table 3.0: Dialectic Processes and Products of Concern

The next section considers how these dialectic processes and products may be operationalised.

## 5. Operationalising the Dialectic Process: a Framework for Analysing Arguments

The dialectic process shown in Figure 3.0 and Table 3.0, is operationalised below using a framework which provides a conceptual structure within which to model (that is to describe and analyse) argumentative reasoning (of the sort required by the dialectic process). That is, the framework operationalises three key features of the dialectic process, namely: reflection, negative reasoning and positive reasoning (see Section 4) and their associated products. The framework comprises:

- i) a general conceptual model of argumentation (after Toulmin, 1958; Toulmin, et al 1984)
- ii) criteria for assessing the cogency of arguments

These two components of the framework are discussed in Sections 5.1 and 5.2 below.

In Section 6, it is claimed that the dialectic process and its operationalisation supports the practical accommodation of paradigms (and hence supports multidisciplinary practice by practitioner in the field of requirements engineering).

## 5.1. General Conceptual Model of Argumentation

The dialectic process described in Section 4 is predicated upon the need for reflection, negative reasoning and positive reasoning. The purpose of the framework described here, therefore, is to provide an operationalisation of these three processes and their associated products. The first part of the framework comprises a general model of argumentation, which is described below.

In his book, *The Uses of Argument*, Toulmin (1958) devised a general conceptual model of the functional components and structure of complex arguments. This seminal work was based on analysis of reasoning practice (e.g. legal jurisprudence), and is one of the earliest examples of what has become the field now known as *informal logic* (Blair and Johnson, 1980; Kahane, 1992). Toulmin believed that the formal logics of philosophy and mathematics provided little insight into human reason, and he proposed a scheme to analyse the logical structure of everyday arguments. The Toulmin general model proposes conceptual categories which describe the component parts of an argument, and relates these conceptual categories by laying them out in a pattern which is intended to make explicit the sources of an argument's validity.

Initially, Toulmin distinguishes between: the *claim* (C) or conclusion whose merits the argument is seeking to establish; the *data* (D) which are appealed to as the foundation for the claim; and the *warrants* (W) which are the laws, rules, principles, premises and so on that authorise the movement between the data and the claim. Warrants show that, if one takes some data as a starting point, the step to the claim or conclusion is an appropriate or legitimate one. A warrant is the rationale for the movement from data to claim, and can be thought of as the *because* part of an argument. These three elements comprise the skeleton of a pattern for analysing arguments, as shown in Figure 3.1:

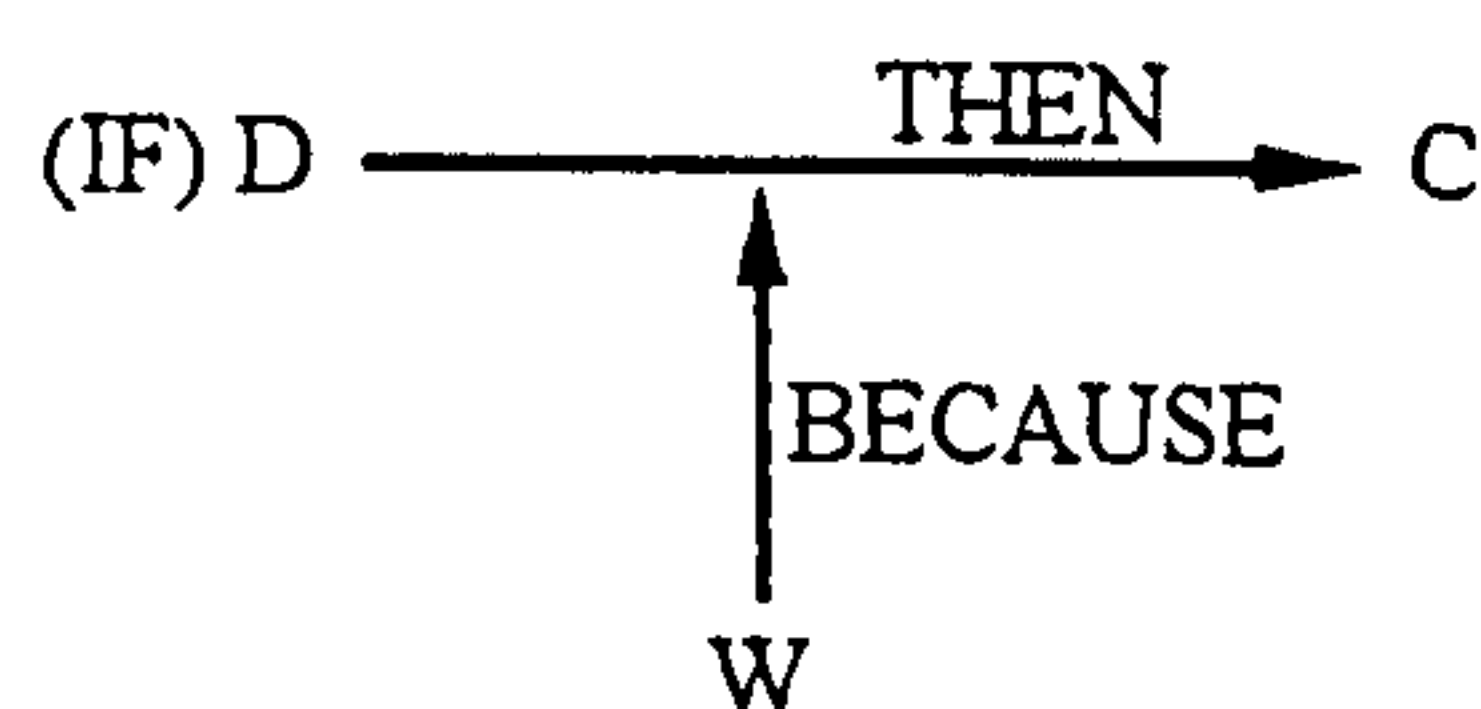


Figure 3.1: Basic Structure for Analysing Arguments

Warrants, however, are of different kinds, and may confer different degrees of support to the conclusions they justify. Some warrants authorise one to accept a claim unequivocally (given the appropriate data). Others authorise one to make the step from data to conclusion either tentatively, or else subject to conditions, exceptions or qualifications. Toulmin, therefore, adds two further concepts to the framework: a *qualifier* (Q) that indicates the degree of support which the data confer on the claim by virtue of the warrant; and a *rebuttal* (R) that indicates the circumstances under which the authority of the warrant would have to



be set aside. Qualifiers and rebuttals help assess the plausibility of an argument. Figure 3.2 illustrates how these two concepts contribute to the pattern of the argument.

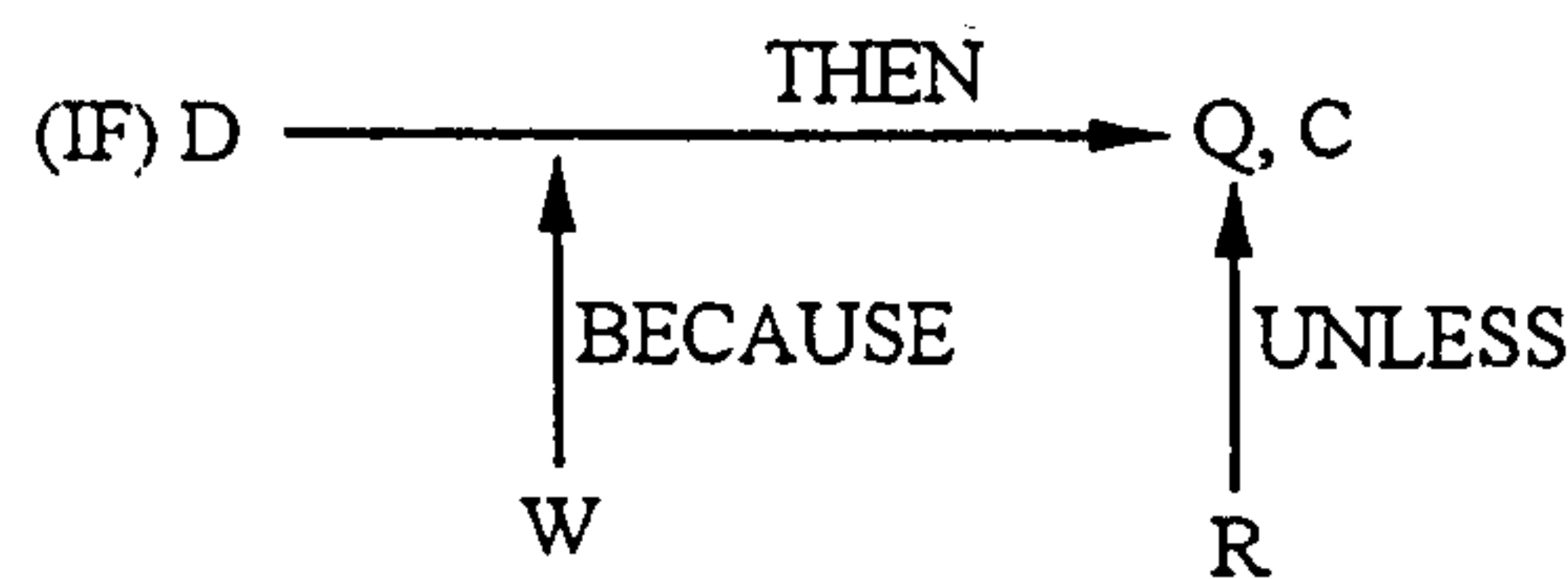


Figure 3.2: Qualifiers and Rebuttals

In addition to the question of whether, or under what conditions, a particular warrant is applicable in a *specific* case, it is often necessary to ask why in *general* a warrant should be accepted as having authority. That is, a warrant always rests on certain other assurances, called *backing* (B), without which the warrants do not possess authority. The backing needed to establish warrants may exhibit great variability, but may include assumptions based on theory, practical experience, beliefs, values, and so on. The backing is included into the argument pattern as shown in Figure 3.3.

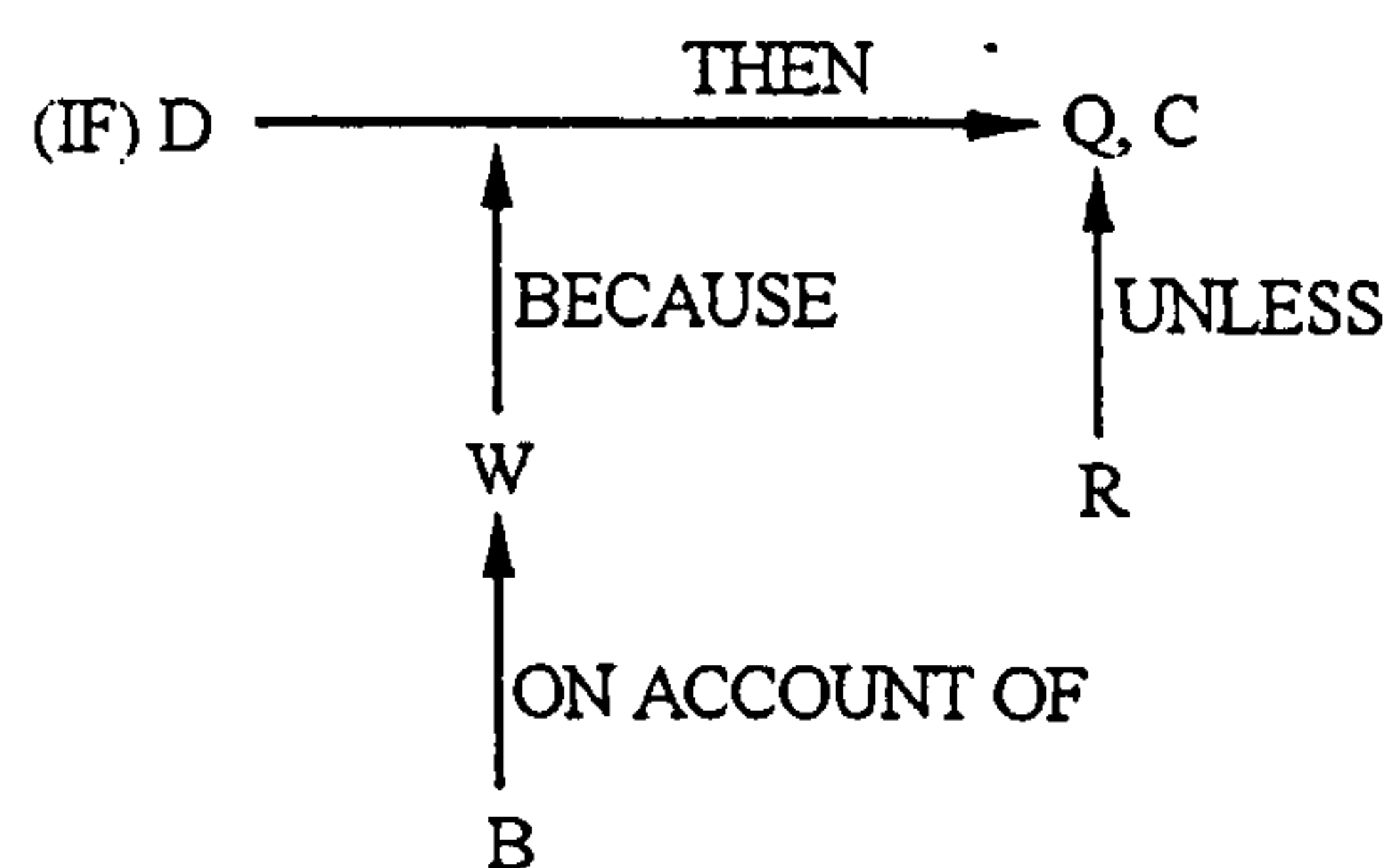


Figure 3.3: Backing

Figure 3.4 shows Toulmin’s original example instantiation of the complete form of the model.

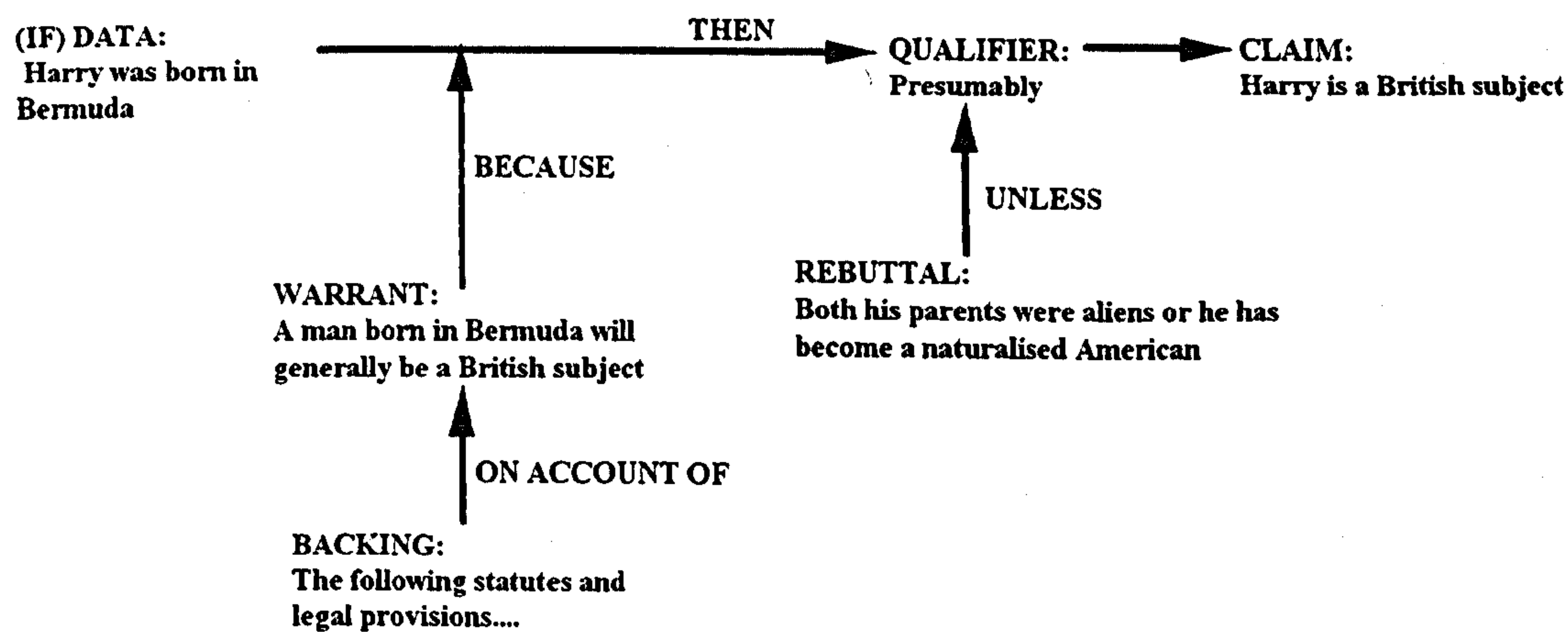


Figure 3.4: Example Instantiation of the Toulmin Model

The general model also allows us to consider multiple chains of argumentation. For example, that data of one argument may be the claim of a previous argument or arguments (see Toulmin et al, 1984). Conversely, challenging a particular claim, may lead to more general challenges to the legitimacy of a whole range of arguments, where the claim of one argument may be the data, warrant or backing of another.

The following sections consider the characteristics of the Toulmin model with respect to the component parts of the dialectic process.

### 5.1.1. Advantages of, and Alternatives to, the Toulmin Model

The Toulmin model has a number of characteristics that make it particularly suitable with respect to the aims of this thesis (i.e. supporting the accommodation of alternative paradigms, and hence supporting dependent multidisciplinary practice).

For example, Toulmin has emphasised in his model that reasoning is often contingent upon the knowledge and beliefs of those conducting the argument, and that our ability to reason is not based on infallible knowledge leading deductively to certain conclusions. Moreover, he suggests that warrants (that is, our assumptions about relationships among 'facts') come from our past experience and beliefs. In addition, and importantly for the dialectic process, the Toulmin model also provides a minimum set of categories for identifying what it is possible to dispute and how (Newman and Marshall, 1990).

There have been a number of other approaches that have used models of argumentation to analyse, understand, and improve problem solving activities (and design in particular). Many of these approaches have originated in the design rationale (DR) community (e.g. MacLean, et al, 1989; Lee and Lai, 1991a, 1991b). Most of these approaches, however, concentrate on representation/notations to support argumentation (see Buckingham Shum et al, 1997) and do not address the structure of argumentative reasoning *per se*. One notable exception is the Argument Representation Language (ARL - Smolensky et al, 1988). ARL provides a detailed, user extensible, vocabulary for describing the elements of an argument and the relations among them. The main aim of ARL is to support written scientific reasoning by providing a representation of the underlying argument structures typically found in academic papers. Because of this orientation, however, ARL is not particularly applicable in the context of system design.

As indicated above, most of the other DR-based approaches are essentially concerned with different argument *representation* schemes or *notations*. For completeness, several of these approaches are briefly outlined below.

Maclean et al (1989, 1991) have proposed the QOC (Questions, Options, and Criteria) notation as a means to represent (mainly HCI) design rationale. QOC aims to encourage designers to break their arguments down into their constituent parts and make the structure of their reasoning more explicit (Duke and Harrison, 1995). In QOC, arguments are broken



down into four constituent parts: *questions* are used to identify key problems in the design; *options* are alternative answers to questions; *criteria* are the means by which one alternative is chosen in preference to another; and *assessments* are the relationships between options and criteria (e.g. *supports* or *objects to*). QOC, has been found to be useful as a medium for *information storage* and a *language* for framing the design space (Buckingham Schum, 1994). However, it does not seem to capture the (cultural) assumptions behind a design, or promote collaboration amongst designers (Karsenty, 1996), particularly when the design space is relatively well understood (Buckingham Shum et al, 1997).

The IBIS (Issue-Based Information System) notation (Kunz and Rittel, 1970) and gIBIS its modern graphical variant (Conklin and Begeman, 1989; Conklin and Burgess Yakemovic, 1991) is broadly similar to QOC, but aims to capture the design process for a single design rather than for a design in relation to its alternatives (Buckingham Schum and Hammond, 1994). In IBIS and gIBIS, designers propose *issues* to which they propose various answers (called *positions*), and then use *arguments* to debate the pros and cons of the proposed answers. Design using IBIS and gIBIS, then, can be characterised as a process of raising and deciding upon appropriate answers to a set of related issues (Shipman and McCall, 1997). However, from our current perspective, the limitations of IBIS and gIBIS is that there are no explicit structures for qualifying an argument or for proposing a counter argument, and it is not possible to isolate the implicit assumptions underlying arguments (Lee and Lai, 1991a).

DRL (Design Representation Language - Lee, 1990a, 1990b; Lee and Lai, 1991b) provides an extensive vocabulary for representing and managing the qualitative elements of decision-making in design, including: the alternatives being considered; evaluations of those alternatives; and the arguments and criteria behind such evaluations. As such, DRL combines a complex representation of the decision problem with a simplified model of argumentative reasoning consisting of claims, qualifications and supports-denies relations. The DRL vocabulary is intended to be extensible according to the needs of the design domain being considered (e.g. Lee, 1991 describes an extension of DRL that supports software engineering). In this sense, DRL emphasises the use of domain-specific models of argumentation, rather than with characterising arguments in terms of their generic functional structure.

In sum, then, the Toulmin model is considered to be most applicable for the purposes of this thesis. It comprises a useful set of distinctions, provides a basic set of categories for understanding how arguments proceed, and seems general enough to capture the basic structure of most argumentative discourse (Newman and Marshall, 1991). It also emphasises the need to explore the knowledge and assumptions (backing) that underlie particular arguments. These features are mostly absent from the other approaches described above which typically focus on design problem decomposition and its representation.

Finally, it is pertinent to note that the Toulmin model has been widely used as an argumentation scheme in a diversity of fields; including: organisational decision making (Mason and Mitroff, 1981); cognitive science (Voss et al, 1983); risk analysis (Faragó et al, 1989); public policy and law (Taylor et al, 1989); group working (Storrs, 1989); and education (Allegretti and Frederick, 1995).

In the next section, we consider some criticisms and enhancements of the Toulmin model.

### 5.1.2. Some Criticisms and Enhancements of the Toulmin Model

Newman and Marshall (1991) in an unpublished technical report suggest that, whilst the Toulmin model provides the minimum elements we need to understand how arguments proceed, some of these elements may be usefully extended, and that different kinds of connectivity between its elements may be possible and desirable. Their work is mostly based on the analysis of legal reasoning in two US Supreme Court cases.

In the current context, their most important criticism is that rebuttals are the most problematic and undeveloped aspect of the Toulmin model.

As discussed in Section 5.1, Toulmin conceptualised rebuttals as the circumstances under which the authority of the warrant would have to be set aside. Toulmin clearly sees rebuttals as being attached to the qualifier, and thus to the relationship between the data and the claim as mediated by the warrant. Newman and Marshall (1991), however, suggest that this conceptualisation is insufficient to characterise the type of legal argument which they studied, and that in particular rebuttals can sometimes attack other elements of the model. These possible different types of rebuttal are considered below.

1) *Rebuttals to the data*: Any of the evidence put forward in support of a claim may be questioned. Such questioning may take the form of providing evidence to the contrary, or by proposing an alternative characterisation of the evidence supplied. Such rebuttals may be concerned with any part of sometimes multiple sources of evidence.

2) *Rebuttals to the claim*: An argument may be rebutted by a counter-claim (with or without evidence). Counter-claims may be of two sorts: those that represent an exception or limiting case to the warrant; and those that represent a complete rejection of the warrant.

3) *Rebuttals to the warrant*: If too many exceptions to the warrant arise, the warrant may be attacked directly (rather than indirectly through its relationship to the data and claim). That is, the basis of the warrant may be attacked as not being relevant to the argument in hand, or sometimes its applicability to the current argument may be questioned by distinguishing the current argument from the arguments in which the warrant originally arose.

4) *Rebuttals to the backing*: One may attack the assumptions (that is, the theory, practical experience, beliefs, values, and so on) underlying an argument by attacking the



backing. Given the paradigm analysis in Chapter 2, this sort of rebuttal may be particularly important with respect to operationalising the dialectic process.

These different types of rebuttals may, as suggested in Section 5.1, be the source of whole chains of counter arguments, where the rebuttal becomes the claim of a previous argument or the data for a subsequent one.

By identifying or constructing rebuttals that count against the features of an argument, we might hope to improve the quality of the argument. How, though, do we assess the quality of an argument? This question is the subject of the next section, and results in further enhancements to the Toulmin model that have been developed for the specific purposes of this thesis.

Finally, before leaving this section, we should mention that there have been some other criticisms of the Toulmin model from work in development of computer supported argumentation environments (such as hypertext authoring systems, for example - see Marshall, 1987; Streitz et al, 1989). Many of these criticisms, however, address the suitability of the model for computerisation, and are not of particular concern here.

## 5.2. Criteria for Assessing the Effect of Rebuttal on an Argument

Thus far, we have argued above that the Toulmin model is suitable as a means to identify and express the underlying features of complex arguments. This section extends this view, and proposes some criteria which can be used to evaluate arguments which have been expressed in terms of the Toulmin model. These resulting evaluative criteria constitute the second part of our framework to operationalise the dialectic process.

There are two basic ways that an argument can fail to be convincing in the light of rebuttal(s): the data, warrant and backing may be unconvincing; or the way that they are used to support the claim may be unconvincing. In the first case, it is the **legitimacy** of the data, warrant, and backing that is being questioned. In the second case, it is the **plausibility** of the claim which is being questioned.

The next sections present some criteria (after Geach, 1976; Rescher, 1976, 1977; Harman, 1986; and Govier, 1992; ) which can be used to assess arguments. These criteria are used to establish the legitimacy of an argument's data, warrant and backing (hereafter collectively called the *grounds* for an argument), and the plausibility of its claims (as evidenced by the reasoning from the grounds to the claim).

## 5.2.1. Criteria for Assessing the Legitimacy of Grounds

The major criterion for assessing the legitimacy of grounds is that of **acceptability**. Other supporting criteria include: **clarity**, **consistency**, **coherence**, and **certainty**.

### 5.2.1.1. *Acceptability*

The grounds of an argument are acceptable if it is reasonable for those to whom the argument is addressed to believe those grounds. Acceptability implies that there is good reason to accept an argument's grounds (even if they are not known for certain to be true), or that there is no good evidence to indicate that the grounds are false or flawed.

Some of the knowledge needed to assess any given argument will be highly specific, but there are, however, certain general conditions under which an argument maybe deemed to be acceptable.

The grounds for an argument may be acceptable if they are the output of a sub-argument that has already been shown to be cogent, or if the grounds are defended elsewhere, or if they are known *a priori* to be true. Grounds for an argument may also be deemed to be acceptable on the basis of a person's testimony, particularly if that person possesses proper authority (e.g. as an established expert in an agreed field of knowledge). Such testimonies, however authoritative, may be unreliable, unsubstantiated, controversial and so on.

Arguments can be deemed as *provisionally* acceptable if one does not have a definite basis for considering them unacceptable. Other criteria can then be used in conjunction with acceptability to evaluate the argument.

### 5.2.1.2. *Clarity (Explicitness)*

The grounds of an argument should not be vague or ambiguous to the point where one cannot determine what sort of evidence would establish them. Grounds must be capable of being explicitly stated in specific or concrete terms (hence resolving vagueness and ambiguity by definition).

### 5.2.1.3. *Consistency*

The grounds of an argument should be consistent in the following ways: of themselves; internally in relation to other components of the argument; and externally in relation to other arguments.

### 5.2.1.4. *Certainty*

The criterion of certainty asks 'how likely are these grounds to be true?' Grounds should be as 'self-evident' and certain to be true as possible. Additionally, given that the purpose of an argument is to lead to a rational acceptance of its claims, the grounds of an argument



should be more certain than its conclusion. In some cases, we make seek to verify the grounds.

#### 5.2.1.5. *Coherence*

The degree to which the grounds for an argument agree with previous knowledge, experience, and beliefs. Coherence implies a mutual support, and mutual intelligibility, between the grounds for an argument (Harman, 1986).

#### 5.2.1.6. *Completeness*

The grounds for an argument should be procedurally complete (that is, there should not be elements missing - e.g. data for instance); and substantially complete (that is, enough information should be provided for the purposes of the argument - e.g. more than one item of data may be required).

### 5.2.2. Criteria for Assessing the Plausibility of Claims

Plausibility is the strength of support that an argument's grounds provide for its claim (Rescher, 1976, 1977), and can be assessed using two related criteria: **relevance** and **sufficiency**.

#### 5.2.2.1. *Relevance*

The grounds of an argument should be relevant to its claims. That is, they should provide at least some evidence in favour of the claim being true or plausible.

We can distinguish between three types of relevance: **positive relevance**; **negative relevance**; and **irrelevance**. Positive relevance is where the grounds for an argument support or count in favour of one another. Negative relevance is where the grounds for an argument undermine or count against one another. Irrelevance is where the grounds neither count for or against one another, and essentially have no relationship between them.

Relevance can be assessed by use of *deductive reasoning*, *analogy*, and *inductive reasoning*. In deductive reasoning, the grounds, when taken together, give full logical support to the claim. If true, they prove the claim, and therefore provide good reason to believe it. In deductive reasoning, then, the truth of the claim is established from the truth of the grounds. This form of formal (and often mathematical) reasoning is least applicable to the structure of argument we have examined, since it is based on traditional models of argument (such as syllogisms) which are not used here.

The use of analogy allows the use of information from one case that may well be relevant to another. When two cases are known to be similar in a number of respects, the use of analogy provides a basis from which to infer that they may be similar in further respects also.

The basic similarities of an analogy can, thus, be used to indicate relevance (but do not provide conclusive evidence of relevance).

In inductive reasoning, it is assumed that past cases are relevant to future ones and inferences are made on this basis; that is, evidence is put forward in support of some further claim. Inductive reasoning can be usefully classified into categories such as: reasoning from generalisation (that is, extrapolating from a sufficiently large and representative sample to the population as a whole); reasoning from sign (that is, reasoning from indicators which signal the presence of some referent); and reasoning from cause (that is, reasoning about the connection between conditions or events). Like analogies, and unlike deductive reasoning, inductive arguments cannot absolutely prove their claims to be true.

#### 5.2.2.2. *Sufficiency*

The grounds of an argument should provide sufficient support or evidence for the claim. That is, in addition to being relevant (counting as evidence for the claim), the grounds should provide enough evidence, or enough reasons, taken together, to make it rational to accept the claim.

The relevance of grounds is distinguished from their sufficiency because though the grounds of an argument may be relevant to a claim they may not provide enough evidence to render it plausible. On the other hand, if the grounds of an argument provide sufficient evidence to make it rational to believe the claim, they will be relevant as well.

There are various sorts of sufficiency (and hence a number of ways by which grounds may be properly connected to a claim), including both formal logic (e.g. categorical and propositional logic) and informal logic (e.g. inductive support, analogy and conductive support).

For the purposes of this thesis, we will concentrate on conductive support and ignore formal deductive logic, inductive reasoning and reasoning by analogy. The reason for this decision, is that by adopting the Toulmin model we are structuring arguments as a number of grounds which if taken together offer support to the claim being made. That is, in conductive reasoning the grounds support the conclusion convergently, rather than in the linked way typical of formal deductive logic, inductive reasoning and reasoning by analogy. Additionally, the recognition of rebuttals is a common feature of conductive argument, where a rebuttal can be seen as being negatively relevant to the claim.

Fundamentally, evaluating the sufficiency of an argument depends on how the data, warrant and backing weigh up against the rebuttal. It is a creative task of evaluation to determine how much the rebuttal counts against the claim or whether the grounds outweigh their impact. In this sense, to assess the sufficiency of an argument, one has to construct a judgement about the relationship of the grounds to the claim in the light of the rebuttal.



Such judgements must balance all considerations, and whilst it would be difficult to reduce the process to a simple formula, we can set out a logical process for making judgements:

1. Determine whether the grounds offered to support the claim are **positively relevant** to it (assuming they have already been found to be acceptable).
2. Determine whether any rebuttals are **negatively relevant** to the claim.
3. Identify any other additional rebuttals, not already identified, that are negatively relevant to the claim.
4. Reflect on whether the data, warrant and backing, taken together, outweigh the rebuttals taken together, and make a judgement as to the their sufficiency in supporting the claim. Articulate reasons for that judgement.

Following this procedure helps determine whether the stated grounds provide good reason to accept the claim, and weighs up the pros and cons of an argument in a way which is a typical feature of practical decision-making (Ellman, 1995).

### 5.2.3. Acting on the Assessment of Legitimacy and Plausibility

Arguments that are deemed to be both legitimate and plausible may be thought of as being **cogent** (Govier, 1992). The concept of cogency is similar to the concept of soundness more familiar to formal logicians, but is somewhat broader in scope in that it includes arguments where the reasoning from grounds to claim is valid only in the sense of being credible rather than being logically deduced, and arguments that have plausible claims which are not necessarily known to be true.

For each argument (i.e. requirement) we construct, we must ask if its grounds are acceptable, and its claims relevant and sufficient (in that order) in the light of the rebuttal. If any one of these criteria is not satisfied, then the argument is no longer cogent in the light of the rebuttal(s).

However, to show that an argument is not cogent is to show that its claims are not well supported by the evidence put forward. However, it is important to remember that an argument is not refuted by showing that one or more of its elements is faulty. To refute it, one has to propose an independent argument whose claim contradicts the original claim.

Once we have established that an argument is not cogent, we may wish to take further actions (such as modifying the argument, constructing a new argument and so on). Judging each argument 'in the light of its rebuttals' is important, since we assume that each argument is cogent in and of itself (that is, prior to facing rebuttal).

As we have seen in Section 5.2, assessing the cogency of an argument is essentially an act of judgement supported by the argument framework and criteria to establish the degree of legitimacy and plausibility it exhibits. We can further support such judgements by rating each argument, and making explicit the relationship between legitimacy and plausibility. A

simple graphical technique for making explicit judgements about an argument is shown in Figure 3.5 (amended after Mason and Mitroff, 1981<sup>15</sup>).

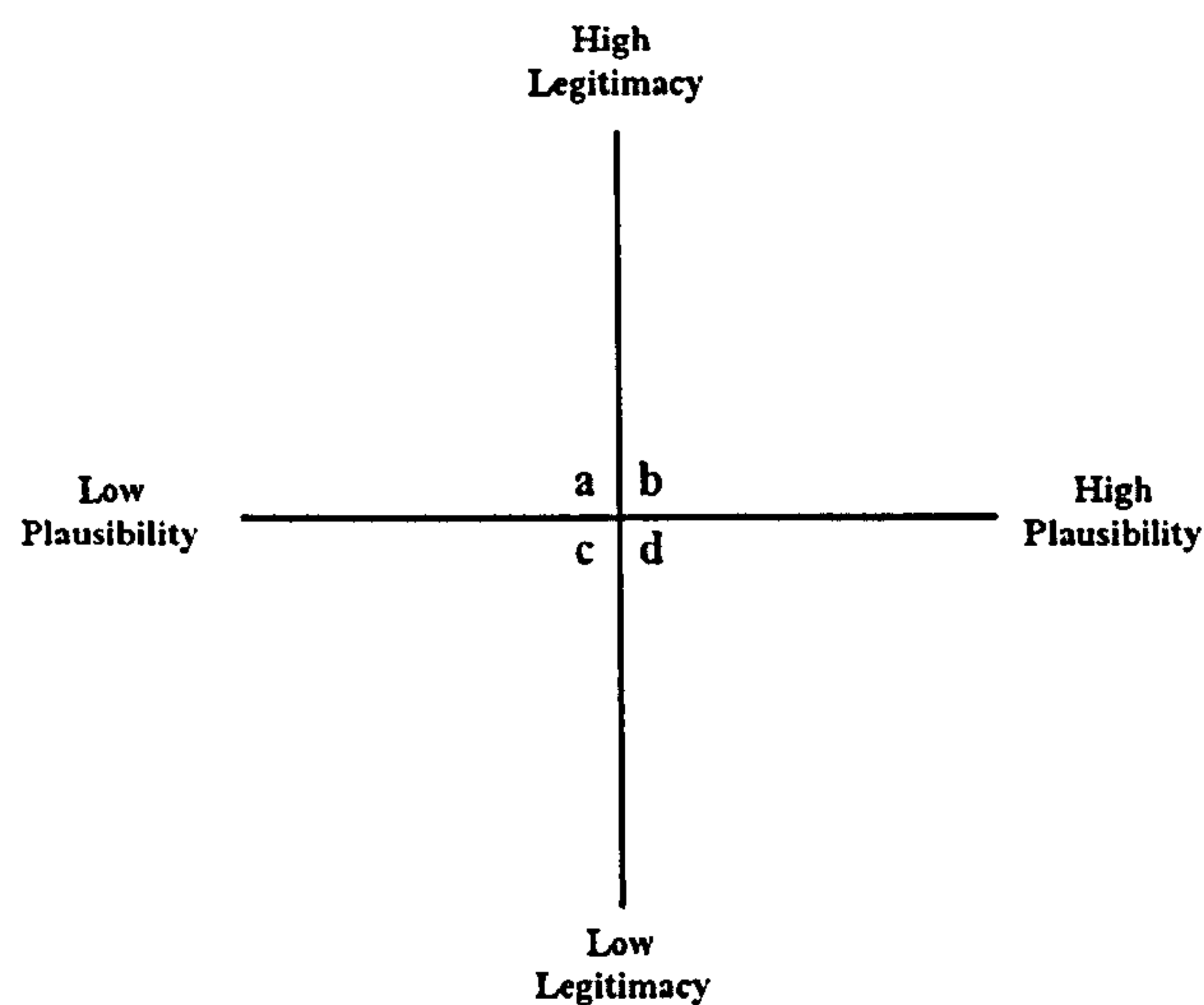


Figure 3.5: Plotting the Relative Cogency of Arguments

The graph represents a two-dimensional ordinal ranking of each argument in the light of its rebuttals, and its purpose is to make explicit the judgement concerning a given argument, and to suggest suitable courses of action according to the argument's relative position on the graph (most importantly, which quadrant it occupies). Each of the four quadrants is considered below.

**Quadrant a: high legitimacy/low plausibility**

This quadrant contains arguments whose claims are placed in doubt even though the grounds for the claim are not questioned. In this case, modification of the claim is suggested.

**Quadrant b: high legitimacy/high plausibility**

This quadrant contains arguments whose rebuttals have provided little or no reason to doubt the original argument at all. In this case, the argument can be accepted without modification.

**Quadrant c: low legitimacy/low plausibility**

This quadrant contains those arguments placed in most doubt in the light of their rebuttals. As such, these arguments demand the most radical actions. There are two possibilities for action here: rejection of the original argument and its replacement with a counter-argument constructed from the rebuttal; or a synthesis of the argument and the counter-argument leading to a resolution of their opposition and the construction of a new more encompassing argument.

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<sup>15</sup> Mason and Mitroff (1981) developed an assumption plotting graph which represents the importance and certainty of business assumptions.



**Quadrant d: low legitimacy/high plausibility**

This quadrant contains arguments whose claims are not doubted even though the grounds for the claim are questioned. In this case, further research and analysis is necessary to improve the grounds for the argument (ultimately moving it into quadrant b).

Table 3.1 summarises the actions taken in response to positions in the quadrant.

	High Plausibility	Low Plausibility
High Legitimacy	Accept Argument	Improve Claim (Further Research)
Low Legitimacy	Improve Grounds (Further Research)	i) Reject/Replace Argument ii) Synthesis

Table 3.1: Actions Taken in Response to Positions in the Quadrant

Finally, as well as suggesting possible actions, the relative position of an argument on the graph also provides a way to prioritise arguments, and allocate available resources to future actions.

**5.3. Summary**

In this section, we have proposed a framework that operationalises the dialectic process and its associated products as described in Section 4. Specifically, the framework operationalises the three key features of the dialectic process of concern here, namely: reflection; negative reasoning; and positive reasoning. It also operationalises the three products associated with these processes, respectively: understanding; dialectic comment; and resolution. The processes, products and their operationalisations are summarised in Table 3.2.

Process	Operationalised Process	Product	Operationalised Product
Reflection	Construct Requirements Argument	Understanding	Specification of Data, Claim, and Warrant
Negative Reasoning	Critique Requirements Argument	Dialectic Comment	Specification of Rebuttals and Qualifiers
Positive Reasoning	Assess Requirements Argument and Act on this Assessment	Resolution	Statement of Cogency of Requirements Argument and Planned Actions

Table 3.2: Dialectic Processes, Products and their Operationalisation

The framework operationalises the dialectic processes as follows. The framework operationalises *reflection* via the construction of a requirements argument. It operationalises *negative reasoning* via the critique of the requirements argument. It operationalises *positive reasoning* via the assessment of the cogency of the requirements argument, and the identification of further courses of action (e.g. the acceptance, rejection or synthesis of arguments, modification of claims; or further analysis).

The framework operationalises the dialectic products as follows. It operationalises *understanding* via the specification of the data, warrant, background and claims of an argument. It operationalises *dialectic comment* via the specification of rebuttals, qualifiers, and counter arguments. It operationalises *resolution* via the specification of the *cogency* of arguments using explicit *criteria*, and the specification of *future actions* .

In Section 6, we consider how the dialectic approach (that is: the dialectic process, its associated products, and their respective operationalisations) might support the practical accommodation of paradigms.

## 6. Can the Dialectic Approach Support the Practical Accommodation of Paradigms?

In Chapter 2, we proposed a number of criteria that the dialectic approach should aim to meet in order to support the practical accommodation of paradigms, and hence overcome some of the paradigmatic constraints acting upon dependent multidisciplinary practice. For convenience, these criteria are shown again in Table 3.3 below.

<p><b>A. Criteria for the social-community accommodation of paradigms</b></p> <p>Any approach that aims to support the practical accommodation of paradigms should:</p> <ol style="list-style-type: none"> <li>1) Support multiparadigmatic contributions to the same inquiry (Austin, 1990).</li> <li>2) Help practitioners understand the key issues of each paradigm (Crandall, 1990)</li> <li>3) Help practitioners appreciate the views of those operating in a different paradigms (Austin, 1990).</li> <li>4) Allow each paradigm to express itself independently of the other (Burrell and Morgan, 1979).</li> <li>5) Help improve communication between practitioners of different paradigms (Guba and Lincoln, 1989)</li> <li>6) Help practitioners understand the practical implications of alternative paradigm positions (Skrtic, 1990).</li> <li>7) Help practitioners understand alternative beliefs (Burrell and Morgan, 1979).</li> <li>8) Help practitioners understand the values and norms of alternative paradigms (Schön, 1983).</li> </ol> <p><b>B. Criteria for the individual accommodation of paradigms</b></p> <p>Any approach that aims to support the practical accommodation of paradigms should:</p> <ol style="list-style-type: none"> <li>9) Bring the role of the paradigm into the realm of conscious thought (Schön, 1983).</li> <li>10) Support practitioners in the conscious articulation of alternative paradigm positions (Crandall, 1990)</li> <li>11) Help practitioners change their own behaviour and beliefs (Le Compte, 1990).</li> <li>12) Help practitioners use different vocabularies (Barbour, 1980; Jackson and Carter, 1991)</li> <li>13) Support practitioners in the enumeration of specific paradigm positions and criticisms (Reinharz, 1981).</li> <li>14) Support practitioners in the management of commitment and critical reflection (Reinharz, 1981).</li> </ol>
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Table 3.3: Criteria for an Approach to Support the Practical Accommodation of Paradigms



This section illustrates informally how the dialectic approach proposed in this chapter might meet these criteria. Chapter 8 provides a full assessment of the ability of the dialectic approach to meet the criteria, in the light of its practical application to a real-world case study (see Chapter 7).

Here, we examine the three main constituents of the dialectic process (i.e. reflection, negative reasoning, and positive reasoning) and their operationalisation; and its three respective products (i.e. understanding, dialectic comment, and resolution) and their operationalisation; and discuss how the dialectic approach might be said to meet the proposed criteria.

## 6.1. Reflection and Understanding

Reflection is essential if the practitioner is to be able to examine (and sometimes overcome) their biases about what requirements are, what they ought to be, why they are the way they are, how they can be gathered and represented and so on. This analyst based information (as well as the reasons, rationale and assumptions underlying it) must be made explicit, so that the basis of their judgement can be brought to the surface for examination (Esterson, 1970).

Essentially, the framework operationalises reflection insofar as it makes clear all the assumptions upon which the data, warrant, background and claims of a requirement are based. Moreover, reflection requires that practitioners learn to reason (in a coherent and logical fashion) from the claim to the grounds for that claim and back again.

When examining the *backing* to a requirement, the practitioner may examine the underlying assumptions of the technique which generated those requirements. Questions such as: “under what view of the world is this the ‘optimal’ technique to follow?; what does this technique take for granted?; what ground is it standing on?” might be asked.

By examining the *data* on which a requirement is based, practitioners may seek to identify the concepts they supply to practice in terms of how the data are elicited and represented. That is, a practitioner might ask: “what kind of practitioner am I?; what kind of practitioner do I need to be to use this technique?; and am I competent to collect the data required?”

By examining the *warrant* that justifies a requirement, the practitioner might seek to identify the benchmarks of rigour that they have used to justify a claim, and the ontology, methodology and epistemology to which they are appealing.

When examining the *claims* made by a requirement the practitioner might ask: “is this requirement congruent with my fundamental values and beliefs?; or, do I like what I get when I specify this requirement?”

Reflection, then, makes practitioners aware of the way that he or she has framed the requirements problem, and alerts them to the possibility of alternative ways of framing it

(Schön, 1983). Practitioners must take notice of their values and norms to which they have given priority, of those that they have given less importance, and of those which they have left out altogether (Schön, 1983).

The dialectic approach generates a deeper understanding of the current assumptions that have underpinned the development of interactive system requirements, and also a deeper understanding of alternative assumptions that could be used instead. The approach may also provide an appreciation of the fact that different stakeholders conceive of requirements in different ways, and why it is important to respect such differences.

Making such assumptions explicit has the benefits of allowing judgements to be made about the efficacy of the assumptions, raises pertinent issues that might have otherwise been ignored, and also stimulates doubt (Mason and Mitroff, 1981) which is the subject of the next section which addresses negative reasoning.

In sum, relating the arguments presented above to the criteria proposed in Table 3.3, we might say (informally at least) that via the support it provides for reflection the dialectic approach meets criteria 5, 6, 9, 10 and 14. That is, it can:

- 5) Help improve communication between practitioners of different paradigms (Guba and Lincoln, 1989)
- 6) Help practitioners understand the practical implications of alternative paradigm positions (Skrtic, 1990).
- 9) Bring the role of the paradigm be brought into the realm of conscious thought (Schön, 1983).
- 10) Support practitioners in the conscious articulation of alternative paradigm positions (Crandall, 1990)
- 14) Support practitioners in the management of commitment and critical reflection (Reinharz, 1981).

## 6.2. Negative Reasoning and Dialectic Comment

Negative reasoning serves the purpose of unearthing assumptions, testing our prejudices, and challenging our existing concepts (Posner et al, 1982). In the process of determining opposing arguments, and specifying rebuttals to requirements and their grounds, practitioners undergo a process of discovering inadequacies in their arguments by explicitly looking for conflicts between the outputs of different requirements models and techniques.

The framework operationalises negative reasoning insofar as it supports reasoning about rebuttals, qualifiers, counter requirements and their assumptions.

Specifying a *rebuttal* forces the practitioner to reconsider the argument and its components. Practitioners, then, must be able to determine the points at issue, and recognise alternative positions as different. The general model of argumentation supports negative reasoning by allowing the expression of different specific models. In this sense, the



framework supports the detection of inconsistencies and ineffectiveness in the construction of requirements.

There is a paradox in negative reasoning, however, in that the practitioner must learn to maintain a commitment to his or her perspective (in order to best act upon it) whilst developing a readiness to abandon it. But one benefit of negative reasoning is that the complex cognitive conflict between opposing ideas is out in the open.

Negative reasoning, then, provides the practitioner with an opportunity to try to understand an alternative position and the consequences and implications of its application or adoption. During the process of negative reasoning, practitioners attempt to contradict their understanding, and (if necessary) to change their concepts and assumptions, which is the subject of the next section which addresses positive reasoning.

In sum, relating the arguments presented above to the requirements proposed in Table 3.3, we might say (informally at least) that via the support it provides for negative reasoning the dialectic approach meets criteria **1, 3, 4, 10, 13 and 14**. That is, it can:

- 1)** Support multiparadigmatic contributions to the same inquiry (Austin, 1990).
- 3)** Promote an appreciation of the alternative views of different paradigms (Austin, 1990).
- 4)** Allow each paradigm to express itself independently of the other (Burrell and Morgan)
- 10)** Support practitioners in the conscious articulation of alternative paradigm positions (Crandall, 1990)
- 13)** Support practitioners in the enumeration of specific paradigm positions and criticisms (Reinharz, 1981).
- 14)** Support practitioners in the management of commitment and critical reflection (Reinharz, 1981).

### 6.3. Positive Reasoning and Resolution

The major purpose of positive reasoning is not to justify one's own view or to attack the weaknesses of other views, but to form a connection between them that allows their mutual exploration by all parties (Guba and Lincoln, 1989). The aim of this process is to reach a consensus decision when that is possible. When such a consensus is not possible, the process at the very least exposes and clarifies the several different views and allows the building of an agenda for further research and argumentation. The process might be thought of as successful (even when consensus is not achieved), if all views are given full consideration and new levels of information and sophistication are reached (Mason, 1969).

Positive reasoning, in contrast to negative reasoning, grasps the interconnections between concepts, not just their differences, and helps practitioners to see the larger picture. In the face of contradictions, its goal is to resolve differences of opinion and perspective by looking for a new point of view (Eemeren and Grootendorst, 1992; Yadav and Khazanchi, 1992).

The framework operationalises positive reasoning, insofar as it allows us to judge the *cogency* of arguments, using explicit *criteria*, and supports reasoning about *future actions* (where further action might comprise: acceptance, rejection or synthesis of arguments, modification of claims; or further analysis, for example).

Positive reasoning, then, searches for creative resolutions in the face of conflict, and as such demands a discussion-minded attitude, starting from an increased awareness of one's own conceptual position and the opposition to it (via reflection and negative reasoning). It also demands that we be prepared to clarify and develop our current notions.

Finally, it is worth noting that not only may the requirements be reconstructed but the practitioners themselves may reconstruct their own conceptual positions (Gadamer, 1975; Solomon, 1983). For example, positive reasoning may support speculation about personal beliefs. Although beliefs cannot be immediately switched on and off at will, they are to some extent under our control and may be modified (Geach, 1976).

In sum, if the process of positive reasoning is successful, the dialectic practitioner may have built a new agenda for negotiation, and may have reconstructed the concepts with which he or she began, and in so doing have developed a more informed and sophisticated perspective.

In sum, relating the arguments presented above to the requirements proposed in Table 3.3, we might say (informally at least) that via the support it provides for positive reasoning the dialectic approach meets criteria 1, 4 and 5. That is, it can:

- 1) Support multiparadigmatic contributions to the same inquiry (Austin, 1990).
- 4) Allow each paradigm to express itself independently of the other (Burrell and Morgan)
- 5) Support communication between different paradigms (Guba and Lincoln, 1989)

## 6.4. Summary

In sum, this section has illustrated how the dialectic approach might have the potential to support the practical accommodation of paradigms which was mooted in Chapter 2 as being necessary in order to overcome the problems associated with dependent multidisciplinary practice by practitioner. A more comprehensive assessment is provided in Chapter 8.



# 7. Applying the Dialectic Approach to Dependent Multidisciplinary Practice in Requirements Engineering

To test the proposal that the dialectic approach might have the potential to support the practical accommodation of paradigms, we first have to select some appropriate paradigms/disciplines to be placed in dialectic relief. That is, we have to select some techniques to which the dialectic approach can be applied. Appropriateness can be judged, in the context of this research, by the degree of opposition and conflict between the paradigms/disciplines. That is, a dialectic approach typically requires at least two alternative perspectives which are in opposition, and each must be an adversary to the other in some way.

## 7.1. Selecting Two Alternative Paradigms

To select two alternative paradigms to place into dialectic relief, we will utilise the most general (and, therefore, most widely applicable) of the three paradigm perspectives discussed in Chapter 2; that is, the work of Guba and Lincoln (1989, 1994). Few people in any field (apart from some postmodernists, perhaps) would object to being asked to make clear their ontology, epistemology and methodology.<sup>16</sup>

Table 3.4 summarises the four paradigms proposed by Guba and Lincoln (1989, 1994), whilst the following sections examine the basic beliefs of the paradigms in more detail.

	Positivism	Postpositivism	Critical Theory	Constructivism
Ontology	Realism	Modified Realism	Historical Realism	Relativist
Epistemology	Objective	Modified Objective	Subjective	Subjective
Methodology	Manipulative	Modified Manipulative	Transformative	Facilitative

Table 3.4: Basic Beliefs of Four Alternative Paradigms

<sup>16</sup> Conversely, this high level of generality means that practitioners of a given perspective within each paradigm are likely to find much to disagree with.

### 7.1.1. Basic Beliefs of Positivism

*Ontology: Realism.* The basic belief of positivism is rooted in a realist ontology, that is, the belief that there exists a reality “out there,” driven by immutable natural laws. The business of science is to discover the true nature of reality and how it truly works. Knowledge of the way things are is conventionally summarised in the form of generalisations, some of which take the form of cause-effect laws. The ultimate aim of science is to predict and control natural phenomena. The basic posture of the paradigm is argued to be both reductionist and deterministic (Hesse, 1980).

*Epistemology: Dualist/Objectivist.* Once committed to a realist ontology, the positivist is constrained to practice a dualist/objectivist epistemology in which the investigator and the investigated object are assumed to be independent entities, and the investigator to be capable of studying the object without influencing it. If threats to validity are recognised, then strategies are followed to reduce or eliminate it. Replicable findings are regarded as true.

*Methodology: Experimental and manipulative.* Questions and/or hypotheses are stated in propositional form and subjected to empirical test to verify them. Possible confounding conditions must be carefully controlled to prevent outcomes from being improperly influenced.

### 7.1.2. Basic Beliefs of Postpositivism

Postpositivism is best characterised as a modified version of positivism which has tried to limit, and adjust to, damaging criticism on issues such as values, ethics, politics, and so on.

*Ontology: Critical realism.* Postpositivism moves from naive realism to critical realism. The essence of this position is that although a real world driven by real natural causes exists, it is impossible for humans truly to perceive it with their imperfect sensory mechanisms and flawed intellect. Inquirers need to be critical of their own work, precisely because of those human frailties.

*Epistemology: modified dualist/objectivist.* Dualism is largely abandoned as not possible to maintain, but objectivity remains a regulatory ideal with the recognition that such objectivity cannot be achieved in any absolute sense. It can be achieved by striving to be as neutral as possible. Emphasis is placed on external guardians of objectivity, such as critical traditions and professional peers. Replicated findings are probably true, (but always open to falsification).

*Methodology: Modified Experimental/Manipulative.* Since the human sensory and intellectual mechanisms cannot be relied upon, the findings of an enquiry should be based on many sources of data, investigators, theories, and models as a way of falsifying (rather than verifying) hypotheses. Relying on many different sources also makes it less likely that



distorted interpretations will be made. Inquiry may be carried out using qualitative techniques in more natural settings, collecting more situational information, and reintroducing discovery as an element in inquiry.

### 7.1.3. Basic Beliefs of Critical Theory

The label critical theory is not really adequate to encompass all the alternatives that can be included in this paradigm. However, one thing that all the alternatives have in common is that they are ideologically oriented (e.g. Marxism, feminism, participatory inquiry and so on). Critical theory may itself be usefully divided into three sub-strands: post-structuralism; post-modernism; and a blending of these two. However, all the critical approaches share a common perspective insofar as they reject the claim of value freedom made by the positivists and largely continued by the postpositivists.

*Ontology: Historical realism.* A reality which is assumed to be apprehendable, and though once plastic, it has been shaped over time by social, political, ethnic, and gender factors and then crystalised into a series of structures that are now (inappropriately) taken as real, that is natural and immutable. For all practical purposes, the structures are real and constitute an historical or virtual reality.

*Epistemology: Transactional and subjectivist.* The investigator and the investigated object are assumed to be interactively linked, with the values of the investigator (and of situated others) inevitably influencing the inquiry. Findings are therefore value-mediated. This posture effectively challenges the traditional distinction between ontology and epistemology as what can be known is inextricably linked with the interaction between a *particular* investigator and a *particular* object or group.

*Methodology: Dialogic and dialectical.* The transactional nature of critical inquiry requires a dialogue between the investigator and the subjects of the inquiry is. The aim of critical inquiry is to transform the “real” world (that is, immutable historically mediated structures) by raising the consciousness of the participants so the dialogue must be dialectic in nature in order to transform their misapprehensions.

### 7.1.4. Basic Beliefs of Constructivism

Guba (1990) believes that proponents of both the postpositivist and critical theory think that an accommodation between their positions and indeed with positivism is possible. It is the ontological similarities that make such accommodation possible. In contrast, it is the ontological position that most differentiates constructivism from the other three paradigms.

*Ontology: Relativist.* There are many interpretations that can be made in any inquiry, and there is no foundational process by which the ultimate truth or falsity of these several constructions can be determined. Realities are apprehended in the form of multiple, intangible, mental constructions, socially and experientially based, local and specific in

nature (though elements are often shared among many individuals and even across cultures), and dependent for their form and content on the individual persons or groups holding the constructions. Constructions, then, are not more or less “true” in any absolute sense, but simply more or less informed and/or sophisticated. Constructions are alterable, as are their associated “realities.”

*Epistemology: Transactional and subjectivist.* The investigator and the investigated object are assumed to be interactively linked, so that the findings are literally created as the investigation proceeds. As in the case of critical theory, the traditional distinction between ontology and epistemology disappears.

*Methodology: Hermeneutical and dialectical.* The variable nature of personal and social constructions suggests that individual constructions can only be elicited only through interaction between and among the investigator and the respondents. The constructivist proceeds in ways that aim to identify the variety of constructions that exist and bring them into as much consensus as possible. This process has two components: hermeneutics and dialectics. The hermeneutic aspect consists in depicting individual constructions as accurately as possible, while the dialectic aspect consists of comparing and contrasting these existing individual constructions so that each respondent must confront the constructions of others and come to terms with them. The aim is to distil a consensus construction that is more informed and sophisticated than any of the predecessor constructions (including that of the investigator).

### 7.1.5. Selecting Paradigms

As suggested in Section 7, for the purposes of applying the dialectic approach, we should select alternative paradigms on the basis of the degree of opposition and conflict between them.

From the discussions above, we can see a clear *epistemological* division between positivism/postpositivism and critical theory/constructivism; i.e. a division between *objectivist* and the *subjectivist* viewpoints. These two positions differ mostly with respect to the importance granted to the subject (the knower) and the object (what can be known) in the knowing activity.

The objectivist view posits that knowledge originates from the object, and assumes that knowledge results from experience obtained through the senses. Objectivism assumes the existence of a reality that is external and independent of the knowing subject, and also assumes that this reality can be known (to varying degrees and perhaps imperfectly) through experience. The subject, playing no part in the organisation of objects uncovered by experience, has a passive role in the process of knowledge production (Landry, 1995).

The subjectivist view posits that knowledge originates from the subject, and minimises the role of the object in the process of knowledge acquisition. The perceived organised



properties of known objects are seen as dependent upon the subject. The subject here has an active role in the process of knowledge production; knowledge is created not discovered by the subject. In its idealistic form, subjectivism holds that what is real is a construction in the minds of individuals.

Additionally, we can see that it is its *ontological* position that most differentiates constructivism from the other three paradigms, and that this position pushes the epistemological position further towards the idealistic form of subjectivism (that is, where what is real is assumed to be a construction in the minds of individuals). The relativism of its ontology means that there are multiple often conflicting constructions and all (at least potentially) are meaningful (Schwandt, 1994).

Given these arguments, we can see that there is considerable opposition between **constructivism** and either of the two conventional paradigms (that is, positivism or postpositivism) whose epistemological positions are broadly similar (objectivism remaining a regulatory ideal even in postpositivism). However, for the purposes of this thesis we will select **postpositivism** as the paradigm to place in opposition to constructivism, since it probably reflects the position most representative of many techniques in current requirements engineering practice (excepting perhaps some forms of formal systems analysis - e.g. Greenspan; 1984).

## 7.2. Selecting Two Alternative Disciplines

Having selected our alternative paradigms, we next need to select disciplines which can contribute to the field of requirements engineering, and which include techniques which are representative of these paradigms.

Obviously, a discipline (such as sociology, say) may include theories and techniques that belong to more than one paradigm (e.g. the Chicago School and the Frankfurt School representing positivism and critical theory respectively). Because of this, we might select disciplines on the basis of their general contribution to requirements engineering, and then characterise selected techniques in terms of their specific paradigm features to ensure dialectic opposition.

For the purposes of this thesis, we will select the disciplines of **human factors (HF)** and **sociology**, both of which are frequently used in interactive systems development in general and requirements engineering in particular (e.g. Macaulay, 1996; Jirotko and Goguen, 1994).<sup>17</sup>

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<sup>17</sup> It would be disingenuous, however, to claim that the selection of these two disciplines was not influenced by pragmatic considerations. HF was an obvious choice because the author has worked in the field of HF for some years; and sociology was a preferred choice because it is an area of current concern in requirements engineering (and was also an area that the author was broadly familiar with through his first degree in the human sciences).

### 7.3. Selecting Two Alternative Requirements Engineering Techniques

Having selected our two disciplines, it is necessary to select two techniques from within these disciplines which can be said to represent the two alternative paradigms of post-positivism and constructivism. The two selected techniques are the **MUSE** method for usability engineering (Lim and Long, 1996) and **Grounded Theory** method (Glaser and Strauss, 1967; Strauss and Corbin, 1990).

Neither of these two techniques could be said to be prominent in requirements engineering. Both techniques, however, have a number of features that make them suitable vehicles for constructing requirements.

For example, the MUSE method includes an Information Elicitation and Analysis phase which explores existing user tasks and results in the production of a Statement of User Needs. MUSE has also been used previously in the early phases of the system development process for domain modelling (Stork and Long, 1997), design problem analysis (Stork and Long, 1994), and user requirements analysis (Stork et al, 1995). With respect to the characterisation of RE proposed in Chapter 1, MUSE is used here to: construct an *understanding* of the requirements problem via the construction of task descriptions and task models of both the existing and the target worksystems; and to construct a *specification* of the requirements for a software product via the construction of task descriptions and task models to support the conceptual design of the target worksystem. MUSE *represents* the outputs of each of these processes using semi-formal notations such as structured diagrams.<sup>18</sup>

The Grounded Theory method is also considered to be suitable as a requirements engineering technique, insofar as, in common with the ethnographic approach, it can be used to construct a rich description of the everyday realities of the work situation. The Grounded Theory method has also been used previously in knowledge elicitation (Pidgeon et al, 1991).<sup>19</sup> With respect to the characterisation of RE proposed in Chapter 1, the Grounded Theory method is used here to: construct an *understanding* of the requirements problem via the construction of a rich description of work practices and organisational/social culture in the workplace; and to construct a *specification* of the requirements for a software product insofar as the construction of analytic categories can

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<sup>18</sup> Using the MUSE method to support the process of requirements *validation* is not addressed here.

<sup>19</sup> Again, it would be disingenuous to claim that the selection of these two techniques was not influenced by pragmatic considerations (especially since neither of the selected techniques could be said to be prominent in RE). MUSE was an obvious choice because it had been developed in-house in the Ergonomics & HCI Unit where the author was a student; and Grounded Theory was a preferred choice insofar as there are a number of excellent reference books and manuals (which the author was broadly familiar with through his first degree in the human sciences) to support the novice sociological practitioner.



be used to develop an understanding of potential requirements. The Grounded Theory method *represents* the outputs of each of these processes using qualitative, detailed, natural language descriptions.<sup>20</sup>

The two techniques and their features are discussed in detail in Chapters Five and Six, but Table 3.5 contrasts their underlying paradigm positions.

	MUSE (Postpositivist Paradigm)	Grounded Theory Method (Constructivist Paradigm)
Ontology	Assumes an external reality characterised as work performed by systems.	Assumes multiple internal realities that are products of human intellects.
Epistemology	Concerned with generalisable knowledge associated with objectively observable behaviours.	Concerned with reconstruction of subjective knowledge of those investigated.
Methodology	Verification of specifications via testing.	Understanding of previously held constructions.

Table 3.5: Basic Beliefs of MUSE and Grounded Theory Method as Paradigm Representatives

In Chapters Five and Six, these two techniques are used to generate requirements for an accident and emergency healthcare information system.

In Chapter 7, the dialectic process is applied to the requirements generated by the methods. This application seeks to illustrate how a dialectic approach can support dependent multidisciplinary practice by practitioner in the field of requirements engineering by supporting the practical accommodation of paradigms.

However, as a preliminary to this more detailed presentation offered in Chapter 7, the next section will briefly illustrate the use of the framework for argumentation with sampled outputs of the two selected techniques (in the domain of emergency healthcare). The aim is to provide a preliminary illustration of how the dialectic approach (via its operationalisation) might support reasoning about the mutual influence of alternative requirements engineering techniques (thereby supporting dependent multidisciplinary practice by practitioner).

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<sup>20</sup> Using the Grounded Theory method to support the process of requirements *validation* is not addressed here.

## 7.4. Preliminary Illustration of the Dialectic Approach (via its Operationalisation)

The following example illustrates the use of the framework for argumentation that operationalises the dialectic process and its associated products.

Figure 3.6 illustrates an argument about a requirement in an A&E worksystem. The illustration is a simplified version of an argument discussed in detail in Chapter 7 (Section 3.8). The A&E worksystem itself is described in Chapter 4.

In this illustrative example, the claim which is to be made is the requirement for the redesign of the A&E worksystem, the data are that which have been gathered via the application of MUSE, the warrant offers support for the interpretation of that data by appealing to the literature, the backing appeals to published statements of intent, the qualifier assigns a probability of need to the suggested requirement, and the rebuttal questions the validity of the requirement by proposing a related piece of data (obtained as an output of the Grounded Theory method) that appears to oppose the claim.

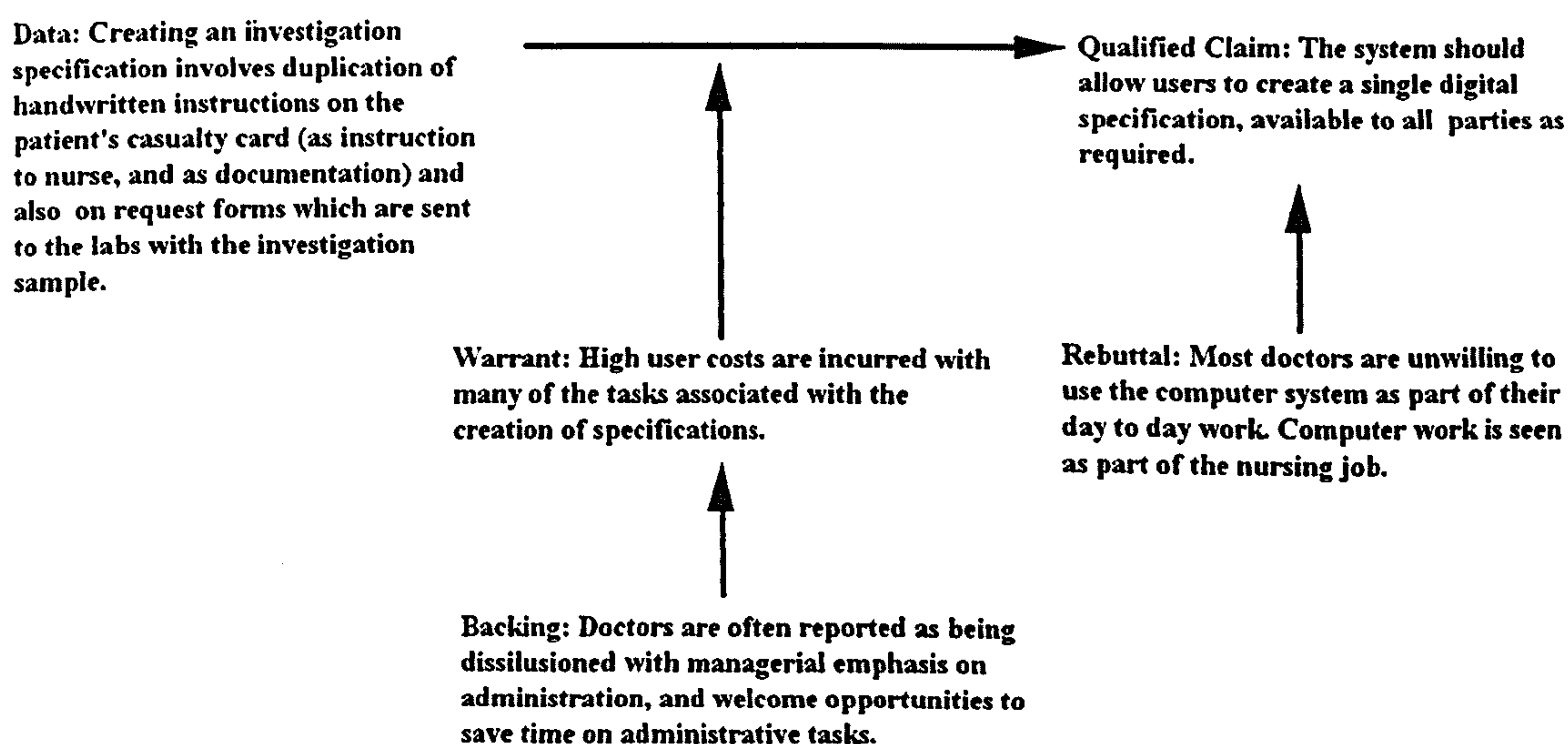


Figure 3.6: Illustrative Requirements Argument for an A&E Worksystem

Having constructed the requirements argument (using outputs from the application of the MUSE method) and critiqued it (using outputs from application of the Grounded Theory method), we need to assess the legitimacy and plausibility of the argument in the light of the rebuttal, and then decide on an appropriate course of action.

With respect to the *legitimacy* of the argument, the grounds for the argument are acceptable. There is no reason to believe that the data, warrant or backing are incorrect



(though no explicit evidence from the MUSE analysis is provided). However, there are a number of concerns with respect to the *plausibility* of the argument. First, the relevance of the backing to the warrant is questionable. The warrant argues that high user costs were identified for many of the tasks associated with the creation of specifications, while the backing argues that doctors are disillusioned with management emphasis on administration. The relationship between the warrant and the backing, then, requires inferences to be made about the relationship between administrative tasks and the tasks necessary to create an investigation specification; which does not preclude the conclusion that the backing may be irrelevant to the warrant.

As for the criterion of sufficiency, the warrant is not sufficient, insofar as we do not necessarily have good reason to believe that writing a single digital specification will reduce user costs. Similarly, the backing is not sufficient insofar as we do not have good reason to believe that creating an investigation specification is viewed by the doctors as an administrative task. The rebuttal implies that doctors see the computer system as supporting the nursing activities rather than their own, but we do not know under what conditions the claim holds against the rebuttal. In general, then, the warrant and the backing do not hold up against the rebuttal, but the rebuttal itself is not strong enough to reject the argument out of hand.

Figure 3.7 shows the assessment of this argument after rating its legitimacy and plausibility.

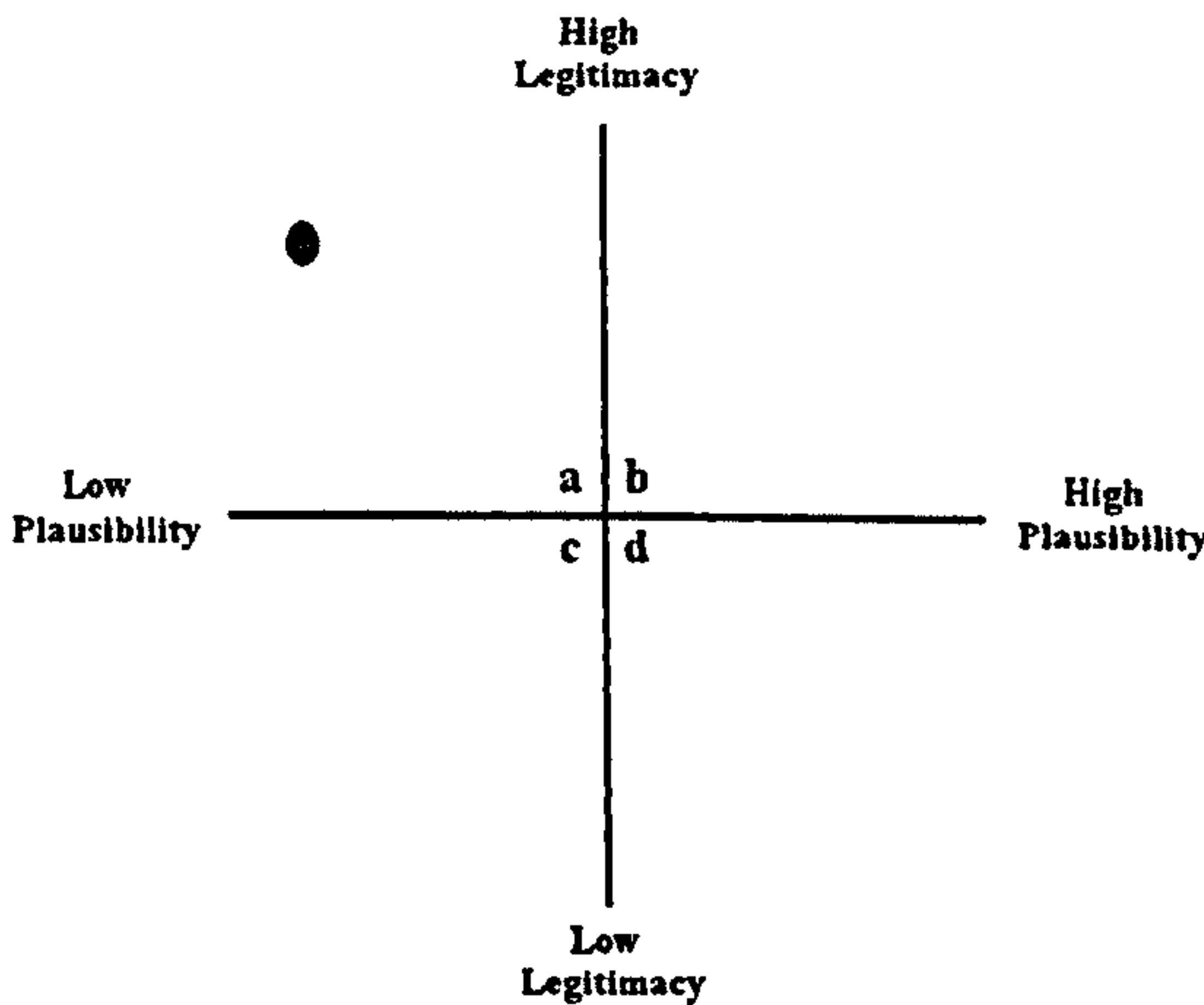


Figure 3.7: Plotting the Relative Cogency of Arguments

The argument is judged to be in quadrant a) which means that its claim is in doubt, even though its grounds are not seriously threatened. In this case, the claim needs serious modification, since its plausibility is judged to be quite low. In this case, further research and analysis is necessary to improve the claim and to establish under what conditions that rebuttal holds. Further research might even push this argument into quadrant c (where it may be rejected or synthesised in the search for a resolution). This requirement certainly requires a reasonable amount of extra effort before it can be accepted.

For the sake of argument, let us assume that further research refines the view that doctors are unwilling to use the computer system, and indicates that doctors are in fact unwilling to input data to the computer (particularly if this involves the use of a standard keyboard). Conversely, they are happy to take outputs from the computer providing that they have easy access to the information they need. In this case, the rebuttal is strengthened with respect to the creation of investigation specifications, leading us to either reject the requirement as it stands, or look for a synthesis which changes the relationship of data input to the creation of single digital specifications. Here, for example, we might look at the role of nurses in supporting doctors in providing digital specifications, or we might look for ways to encourage doctors to change their perceptions of the data input task (by linking data input to the provision of data output, for example). These suggestions are not pursued further here (since the analysis is sufficient for illustrative purposes), but the resolution actually proposed for this argument is discussed in Chapter 7.

## **8. Concluding Comments and Interim Position Statement**

This chapter has provided a 'first pass' development of a dialectic approach that can support multidisciplinary practice by practitioner in requirements engineering by supporting the practical accommodation of paradigms. The dialectic approach is applied in Chapter 7, and assessed and re-developed in Chapter 8.

It is the author's belief that the practical success of interactive systems is dependent upon successful multidisciplinary practice, and that we should strive to develop techniques that might make practitioners more reflective about their own beliefs, and be more willing to be as critical about their own beliefs and opinions as they are about the arguments that challenge them. Such techniques might make significant impact on the quality of requirements engineering practice and ultimately on the interactive systems that we build.

The remainder of this thesis attempts to illustrate this vision in the context of the re-design of an Accident and Emergency healthcare information system. The next chapter introduces healthcare information systems more generally, and provides the context to the Accident and Emergency (A&E) case study to be presented in later chapters.



# Chapter 4

## Context of the Research: Accident and Emergency Healthcare

### 1. Introduction

This chapter outlines the context in which the research described in this thesis was carried out - that is, the domain of accident and emergency healthcare. Section 2 describes some general features of accident and emergency (A&E) services in England and Wales. Section 3 provides an informal description of the particular A&E department studied. Section 4 discusses A&E healthcare information systems in general, while Section 5 introduces the particular A&E healthcare information system studied here. Section 6 describes the data collection process employed, and its limitations.

### 2. Accident and Emergency Services

In England and Wales, patients make approximately 15 million visits to A&E departments each year, with most departments treating an average of 70-200 new patients per day (Audit Commission, 1996).<sup>21</sup> An A&E department typically provides a wide-range of assessment, diagnosis, and treatment services for patients seeking urgent medical care or advice, including:

- immediate resuscitation
- co-ordination of services for treating severe trauma
- care of acute medical conditions
- care of minor injuries
- patients referred by GPs for emergency hospital admission

A&E departments deal with a very diverse caseload (i.e. patients present with a wide range of conditions), and face considerable uncertainty about the number of patients they will have to deal with at any given time. The majority of attenders are discharged home, or into the care of their GP; but about 10% of patients are referred to specialist outpatient clinics, a further 10% are followed-up in A&E clinics (e.g. re-dressing clinics), and about 15% of patients are admitted to the hospital.

A&E departments need 24 hour support from many other specialties and departments within the hospital to assist with diagnosis and treatment, provide specialist expertise,

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<sup>21</sup> The particular A&E department studied here sees an average of 250 patients per day.

process investigations and deliver test results, and so on. Some of the departments and specialties with particularly close links to A&E include: intensive care unit; coronary care unit; paediatrics; pathology and blood transfusion services; radiology and CT scanner services; anaesthesia; orthopaedics; and mental health.

### 3. Informal Description of the A&E Department Studied

This section provides an informal description of the A&E department studied. Broadly speaking, the department comprises six areas:

- **Triage** - where patients are assessed by a nurse who prioritises their need for treatment.
- **Reception** - where patient details are recorded.
- **Waiting area** - where patients wait to be seen by a doctor.
- **Minors treatment area** - where patients with minor injuries and illnesses are seen.
- **Majors treatment area** - where seriously ill patients are seen.
- **Resuscitation room** - where immediate resuscitation is given.

The six areas, and their respective roles in patient care, are discussed below. Additionally, Figure 4.1 provides a schematic of the A&E department.

#### 3.1. Triage

Within a short time of arriving in the department<sup>22</sup>, all patients are triaged by a nurse who makes an assessment of their condition, assigns them to one of the treatment areas (e.g. majors, minors, or resus), and prioritises their need for treatment (e.g. urgent, or routine).

There are two arrival routes into the department - one for ambulance patients, and one for 'walking wounded' - and the triage bay is positioned between these two entrances to allow the triage nurses to work simultaneously with both types of arrivals.

In the case of walking wounded, patients queue at the doorway to triage and are invited in when a nurse is free to see them. An assessment of the patient's condition is made by the triage nurse, and the details recorded by hand on a triage slip which is given to the patient who then takes the slip to the reception desk to register. An example triage slip is provided in Appendix 1.

In the case of ambulance patients, triage may take place either in the triage bay itself, or in a cubicle in the majors area. Typically, a clerk will also come out of reception to take patient details from relatives or ambulance staff.

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<sup>22</sup> At the time that this research was carried out, the Government's target triage time was 5 minutes or less.



A locum consultant physician is also based in A&E from 9am to 5pm to triage patients referred as medical emergencies by their GPs, and to either 'fast track' them to the observation ward or to discharge them.

### **3.2. Reception**

Following triage, patients are registered at the reception desk. Patient details such as name, address, age, sex, next of kin, GP, ethnic group, and so on, are entered directly onto computer. The triage details from the triage slip are also entered onto computer at this time. A Casualty Card (known simply as the 'CAS Card') is then printed, and returned to triage where one of the triage nurses will place it in priority order in one of two trays (majors or minors) for collection by nurses from the appropriate treatment area. Cards for patients requiring immediate attention are taken through to the treatment areas directly. The CAS Card accompanies the patient through the department, and details of any further examinations, diagnoses, tests, treatments and notes are either written directly onto the card or attached to it. An example CAS Card is provided in Appendix 2.

### **3.3. Waiting Area**

Patients without life-threatening problems will typically have to wait in order to see a doctor. Waiting times depend on the priority of the patient, and the demands on the department, and may vary from a few minutes to some hours. Patients are called from the waiting area to the treatment areas by nurses.

### **3.4. Minors Treatment Area**

Nurses from the minors treatment area will periodically collect a number of CAS Cards from triage, and move the patients through from the main waiting area to the minors sub-waiting area. The patients' CAS Cards are then put into an 'in-tray' in the minors area. When a doctor becomes free, they take the next CAS Card from the in-tray and call the patient through into a treatment cubicle for examination. Patients may require further investigations (e.g. X-rays or blood tests) before a diagnosis or treatment plan can be made. Minors patients are often able to walk to the X-ray department unaided, though a porter will accompany them if needed. Blood samples are typically sent to the laboratories via vacuum tubes. Patients may return to the sub-wait area while they await their results.

After seeing a doctor or receiving treatment, the patient is 'disposed' from the department. Disposal can take various forms, including: a decision to admit the patient to the hospital for assessment and treatment by specialists; a referral to a specialist outpatient clinic; discharge under the care of the patients GP; discharge home, and so on. Follow-up appointments to the re-dressing or fracture clinics are also made on disposal.

### **3.5. Majors Treatment Area**

The majors treatment area runs on essentially the same lines as the minors treatment area, but with a slower turnover of patients. Patients are mostly taken through one at a time when a cubicle becomes free, and they typically spend more time in a cubicle whilst awaiting a specialty doctor, or awaiting results of tests. Nurses in majors are divided into two teams, one team per row of treatment cubicles (see Figure 4.1).

### **3.6. Resuscitation Room**

The resuscitation room is typically used in the care of patients with serious multiple trauma (e.g. road traffic accidents) or life-threatening medical emergencies (e.g. cardiac arrest). In both cases, patients will be taken directly to the resuscitation room where a team of A&E doctors, specialty doctors (e.g. orthopaedic surgeons), anaesthetists, nurses, and radiologists may use specialist equipment (e.g. ventilated beds) to either revive or stabilise seriously ill patients.

Figure 4.1 provides a schematic of the A&E department as discussed above.



# Erratum

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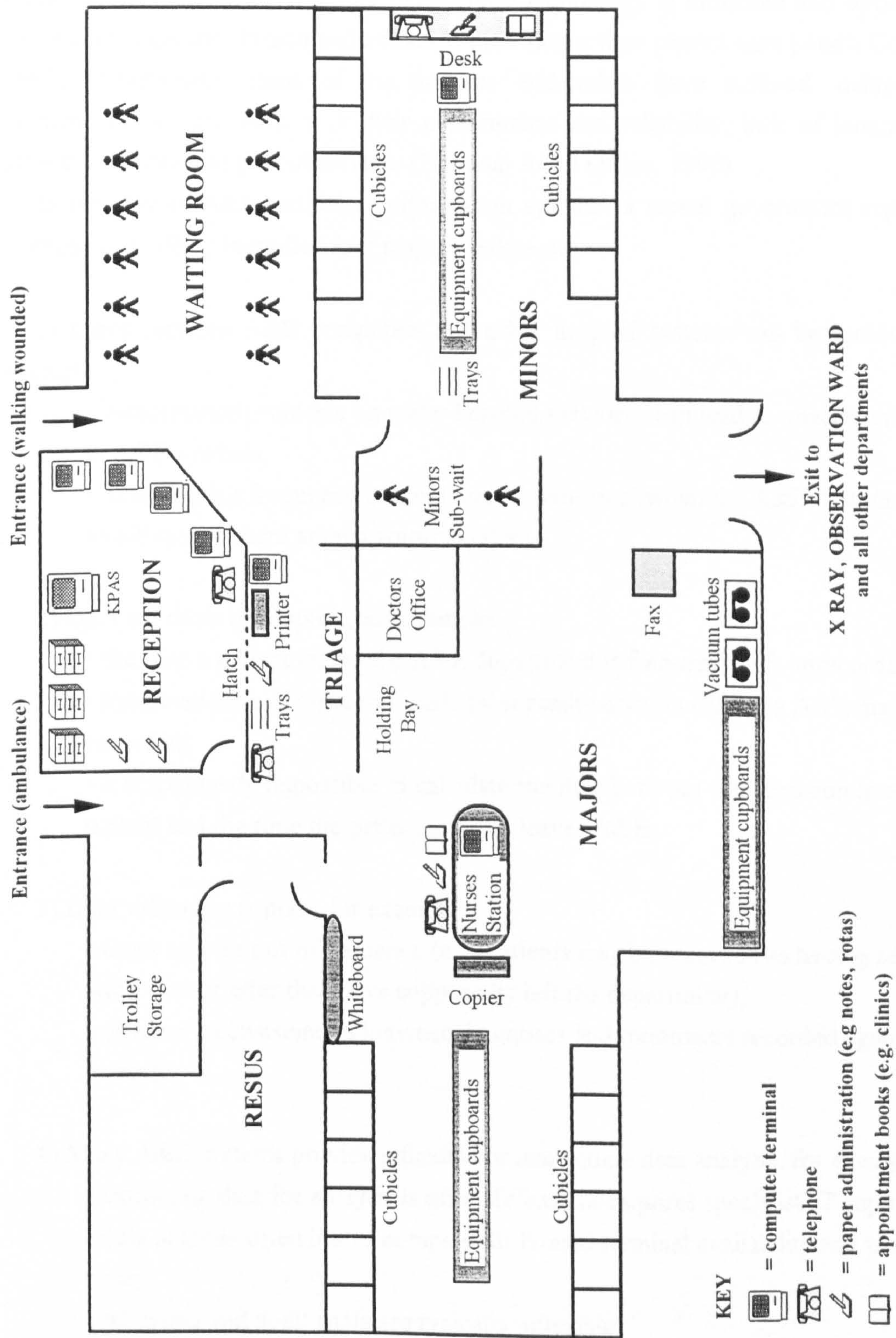


Figure 4.1: Schematic of the A&E department



## 4. A&E Healthcare Information Systems

Since the early 1980s, many of the UK's 260 major acute hospitals have invested heavily in the development of computerised systems to manage information about patients and the care they receive, and the availability and use of resources. However, despite this large scale investment, much of the resulting information technology is inflexible and difficult to use and mainly supports finance and administration rather than patient care (Audit Commission, 1995). Additionally, most of the projects undertaken have suffered: delays in their implementation; problems with their performance and reliability; lack of integration; and little improvement in patient services (National Audit Office, 1996).

In the case of A&E healthcare information systems, a recent government report (Audit Commission, 1996) identified four major weaknesses:

1) Links between A&E computers and other hospital systems can be problematic, for example:

- performance problems on wider hospital networks can lead to unacceptable delays in A&E systems;
- unacceptable frequency of computer 'down-time' when the A&E system is linked to the main patient administration system.

2) Data are often incomplete, for example:

- the time a patient leaves the A&E department is frequently left unrecorded
- examinations and decisions made by specialty doctors called to A&E may not be recorded;
- it is frequently impossible to calculate the time between the 'decision to admit' a patient and the time the patient actually leaves A&E.

3) Data validation is poor, for example:

- times may be out of sequence (e.g. patients may be recorded as having seen an A&E doctor after they have supposedly left the department);
- obvious inconsistencies between diagnoses and treatments recorded against a patient.

4) Many A&E systems provide inflexible or inadequate data analysis, for example:

- extracting data for analysis is often difficult or requires specialist IT support;
- data analysis often has to compete for limited terminal availability and processing time;
- reporting and audit tools are typically inflexible.

# 5. Informal Description of the A&E Healthcare Information System Studied

This section provides an informal description of the A&E healthcare information system studied during this research. Section 5.1 outlines the stages in the development and implementation of the existing system (taken from developer’s records concerning the development process), and Section 5.2 summarises the key features of the existing system.

## 5.1. Development and Implementation Stages

This section outlines the stages and timescales of the development and implementation of the existing A&E system<sup>23</sup>. The system was developed by a small team of one designer/project manager, and three experienced programmers using a powerful ‘fourth generation’ application generator<sup>24</sup>.

- Week 1 Initial specification developed with A&E staff.
- Week 2 First visits made to other hospitals to compare other systems in use.
- Week 3 First prototype installed of registration/triage and disposal system.
- Week 4 Changes in the specification agreed as a result of the prototype.
- Week 5 Visits to other hospitals completed, report formats agreed with A&E, specification of the clinic management system developed and agreed.
- Week 6-13 A number of prototypes were delivered and used by A&E. Feedback from the prototypes was used to improve the specification during development cycle.
- Week 14 System installed.
- Week 15 Live testing commenced (manual systems continued in parallel), further modifications made.
- Week 16 System went live 24 hours a day (manual systems discontinued).

## 5.2. Existing A&E Healthcare Information System

This section summarises the important features of the A&E healthcare information system studied here. Broadly speaking, the system includes facilities for:

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<sup>23</sup> This information is taken from the system developer’s sales brochures, but has been verified informally as being ‘essentially correct’ by the Clinical Services Manager of the A&E department.

<sup>24</sup> Sycero



- Registration
- Disposal
- Post-disposal recording
- Clinic Booking and reception
- Observation ward
- Housekeeping
- Reports

These system features are detailed below. Additionally, Appendix 3 provides menuflow diagrams that list available options within the system.

### 5.2.1.Registration

If a patient has previously attended the A&E department, their details will be held on the Master Patient Index (MPI). The MPI holds basic information about a patient including the name, address, aliases, next of kin, and so on. A patient can be selected from the MPI by either entering their Casualty Number, or by searching the database by surname, forename, date of birth, sex, and patient address. If the patient has not attended the department before, then a new record is created on the MPI when they register. All information held about a patient can be amended.

Once the patient's details have been confirmed or entered, the details of the current attendance are recorded, including: the mode of arrival; the problem causing the visit and how and where it occurred; the date and time of the incident; and so on. Once the episode details are complete, a CAS Card and patient labels are printed.

### 5.2.2.Disposal

As patients leave the department, disposal details are collected. Disposal details include: the time; method (the patient's next destination - e.g. home or admitted to hospital); transport method; and the name of the person disposing of the patient. If the patient is admitted to hospital, the consultant, specialty and ward to which a patient is admitted is recorded.

### 5.2.3.Post-Disposal Recording

Details of investigations, diagnoses, treatments, and members of staff dealing with patients are recorded manually on the CAS card as the patient progresses through the department. When the patient has left, these details are then entered onto the computer. GP letters are also printed during post-disposal.

#### 5.2.4. Clinic Booking and Reception

There are a number of clinics associated with the A&E department, including: the fracture clinic; re-dressing clinic; opthalmic clinic; and so on. If the disposal method is to an A&E clinic, an appointment can be made using a visual diary and calendar program which displays available appointment slots. Appointments can be viewed, moved or cancelled as required. When a patient attends an A&E clinic, they can be selected from a list of patients due to attend that clinic, and the details of their previous attendance reviewed prior to treatment.

#### 5.2.5. Observation Ward

The observation ward sub-system, is essentially a list of which patients are in which beds on the ward. However, the system also indicates whether a patient is awaiting results; is waiting to see a specialty doctor; and whether the named nurse wishes to speak to the patient's relatives should they telephone or visit. Nursing care plans, medications, and treatments may also be recorded on the system.

#### 5.2.6. Housekeeping

The system utilises a number of files which must be maintained to provide key components of the information recorded by the system. These files include: personnel lists; GP lists; clinic lists; other institutions (e.g. nursing homes, schools); and so on.

Other housekeeping tasks include: setting passwords; merging duplicate patient records; changing the number of beds on the observation ward; changing the number of available appointments in A&E clinics; setting-up standard letters; and so on.

#### 5.2.7. Reports

The A&E system produces over sixty reports, all of which can be directed to screen, printer, file or spreadsheet format. Available reports include:

- Daily register - a list of patients attending on a given day with details of the registration time, triage priority, area, disposal time, disposal method.
- Hourly registrations - summarises the number of registrations in each hour for a range of dates.
- Disposal method by month - percentage of referrals for each disposal category for each month of a given year.
- Doctor waiting time - analysis of the waiting time from registration to when the patient is seen by an A&E doctor.
- Disposal waiting time - analysis of the waiting time from registration to disposal for any range of dates.



## 6. Data collection

The above sections have described informally the A&E department, and the A&E healthcare information system, that provide the context of the current research. This section discusses the data collection resources and techniques used.

Chapter 3, described how the application of the dialectic approach in this instance requires the author to perform the role of 'analyst' using both the MUSE method and the Grounded Theory method. This requirement means that the data collected has to be used by both methods, and must be collected before either method is applied, and that cycles of iteration with either method are not possible. These strictures are necessary to avoid (as far as possible) any method bias, and to ensure that the data are collected in as 'neutral' a manner as possible<sup>25</sup>. In sum, data were collected prior to any analysis, and were not tailored to any one particular method. Clearly this means that the data collected are not 'ideal' for either method, and we must <sup>concede</sup> at least some degree of 'analyst bias' based on the author's discipline background in human factors. Some further limitations of this approach to data collection are discussed in Chapter 8.

### 6.1. Data Collection Process

This section describes the data collection process, the techniques used, and the resources available.

#### 6.1.1. Preliminary study

A preliminary study of the A&E worksystem was carried out. The aims of the preliminary study were to: introduce the researcher to key A&E personnel; and to orientate the researcher to the workings of the department. The preliminary study comprised eight hours of unstructured interviews with the information manager, the training manager, the clinical director, the clinical services manager, and a charge nurse. The information manager introduced the researcher to general information technology issues in the health service (and A&E in particular). The training manager introduced the work of the administrative staff in the reception area. The clinical services director addressed the daily clinical organisation, and the research requirements of doctors. The clinical services manager provided a perspective on aspects of the Patients Charter and the data collected for statistical analysis. The charge nurse provided a guided tour of the whole department.

During the preliminary study, data collection techniques were discussed with key A&E personnel. It was agreed that observations of the work of the department would be possible and that access would be granted to all areas (with the exception of the resuscitation room),

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<sup>25</sup> Note that 'neutral' in this context does not equate with 'objective' as commonly understood in the positive and post-positive paradigms.

but that video recording could not be used to protect the privacy of patients and staff. Interruptions of staff would be tolerated, but these should not be excessive. Additionally, a number of interviews with A&E staff of various grades were arranged, and a quiet room was provided.

The main study of the A&E worksystem was then carried out.

### 6.1.2. Main Study

As indicated in Section 6 above, data needed to be collected in as 'neutral' a manner as possible, and for this reason care was taken to ensure that as much information as possible was gleaned from a variety of sources.

#### 6.1.2.1. Background Documentation

Background system development documentation was studied to provide an understanding of the A&E healthcare information system. This documentation comprised:

- user manual for the existing system (see Appendix 3).
- a minimum data set specification (see Appendix 4), that outlines the output data required at a national level with respect to A&E data;
- a requirements specification (see Appendix 5), that details the design and functionality of the system;

#### 6.1.2.2. Observations

Three observational studies were performed. The researcher observed the normal activities of the department during some or all of the three nursing shifts ('early' 7am to 3pm, 'late' 1.30pm to 9.30pm, and 'night' 9pm to 8am). The observations comprised: four hours of the early shift (7am - 1pm); all of the late shift; and five hours of the night shift (9pm-2 am). The night shift was observed on a Friday night (a busy night after the public houses close). Field notes were taken during the observations, and where possible, on-the-job conversations with staff were held.

#### 6.1.2.3. Informal Conversations

Whilst conducting the field observations, the author took the opportunity to spend some time during each shift in the staff room. This time was frequently spent in informal conversations. These informal conversations enhanced the author's understanding of the work of the A&E department, ensured that the majority of staff were aware of who the author was and what he was doing in the department (dispelling any fears of time and motion studies), and facilitated communication in both the field observations and the subsequent interviews.



#### 6.1.2.4. *Unstructured Interviews*

The main part of the data collection exercise comprised a series of unstructured interviews that were recorded and subsequently transcribed. Twelve hours of interviews were conducted. The interviewees comprised:

- sister in charge (grade G)
- charge nurse (grade F)
- two experienced staff nurses (grade E)
- junior nurse (grade D)
- senior A&E consultant
- senior house officer
- house officer

The interviews were conducted over a three day period, and the resulting transcripts amounted to over 50,000 words. A sample interview transcript is provided in Appendix 6.

## 7. Summary

This chapter has described the domain of accident and emergency healthcare, introduced the particular A&E healthcare information system studied in the remainder of this thesis, and has described the data collection process. Chapters 5 and 6 uses these data to construct requirements for the re-design of the A&E healthcare information system from two different perspectives. More particularly, Chapter 5 constructs requirements for re-design through the application of the *MUSE* structured human factors method for usability engineering (Lim and Long, 1994), and Chapter 6 constructs requirements for re-design through the application of the *Grounded Theory* method (Glaser and Strauss, 1967; Glaser, 1978; Strauss and Corbin, 1990).

## Chapter Five

# Requirements for an Accident and Emergency Healthcare Information System - Part 1: Application of a Structured Human Factors Method for Usability Engineering (MUSE)

We (Ergonomists) borrow and invent techniques to serve our special needs.

Alphonse Chapanis, 1990

### 1. Introduction

This chapter constructs requirements for the re-design of an A&E healthcare information system through the application of a method which represents the postpositivist paradigm and the discipline of human factors (see Chapter 3). The method to be used here is the MUSE structured human factors method for usability engineering (Lim and Long, 1994).

With respect to the characterisation of RE proposed in Chapter 1, MUSE is used here to: construct an *understanding* of the requirements problem via the construction of task descriptions and task models of both the existing and the target A&E healthcare information system; and to construct a *specification* of the requirements for a software product via the construction of task descriptions and task models to support the conceptual design of the target A&E healthcare information system. MUSE *represents* the outputs of each of these processes using semi-formal notations such as structured diagrams.<sup>26</sup>

Section 2 outlines the MUSE method. Section 3 presents the application of the method to the A&E data, and shows how it constructs interactive system requirements in the form of a Statement of User Needs which outlines the purpose and performance requirements of the target system. The chapter concludes in Section 4 with consideration of the limitations of the analysis, and the benefits of the analysis, insofar as it may support the re-design of an healthcare information system.

### 2. Overview of MUSE

Lim and Long (1994) report the development of MUSE, a structured human factors method for usability engineering, to improve the practice of HCI practitioners. The primary focus of the method is on design specification to overcome the 'too-little-too-late' problem of human factors contributions to system development. The method was developed using a strategy which involved the iterative proposition of a version of the method followed by

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<sup>26</sup> Using the MUSE method to support the process of requirements *validation* is not addressed here.



testing through the design of some interactive artefact. Versions of the method were, however, also based on an structured conception of human factors support for system design (which in turn was derived from a consensus conception of human factors design). Figure 5.0 shows this structured conception of human factors design (consisting of three phases, each of which comprises a number of design stages) as defined by MUSE.

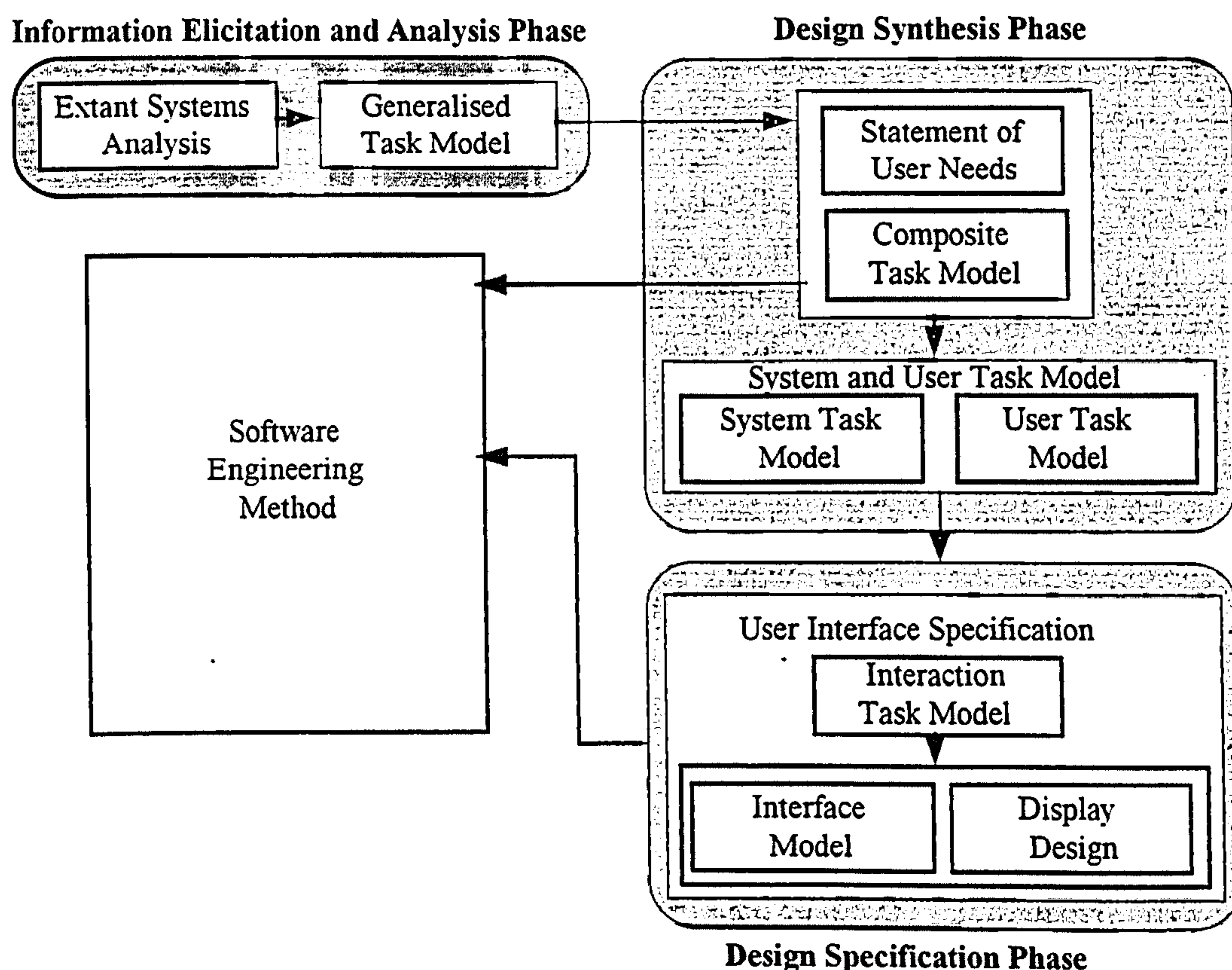


Figure 5.0: Overview of MUSE Method

According to Lim and Long (1994), the scope of the design phases shown in Figure 5.0 is as follows:

- i) *The Information Elicitation and Analysis Phase* is concerned with user requirements capture and task analysis. Its design stages comprise the Extant Systems Analysis and Generalised Task Model Stages.
- ii) *The Design Synthesis Phase* addresses the derivation of a conceptual design of the target system. Its design stages comprise the Statement of User Needs, Composite Task Model, and System and User Task Model Stages.
- iii) *The Design Specification Phase* is focused on functional definition and user interface design. Its design stages comprise the Interaction Task Model, Interface Model, and Display Design Stages.

A summary of each design stage is as follows:

- i) *Extant Systems Analysis Phase*. The scope of this stage comprises the elicitation and analysis of the extant system (including the current and related systems) information (e.g.

user needs and problems); existing task characteristics, design features and rationale. In addition, extant designs are assessed to determine their potential for recruitment to the design of the target system. A wide range of human factors techniques may be recruited at this stage including: techniques for information elicitation (e.g. interviews, observations and so on); techniques to guide the derivation of appropriate task descriptions (e.g. task decomposition, abstraction and generification); and techniques to support the assessment of extant design features (e.g. HF evaluation techniques).

ii) *Generalised Task Model Stage*. The concerns of this stage comprise the generation of device-independent models to facilitate the mapping between relevant extant design features and target system requirements. Two such models are derived: a generalised extant task model that supports the recruitment of extant system features; and a generalised target system model that exposes the conceptual support required by newly introduced system tasks. Existing task analysis techniques (e.g. TAKD, Johnson et al, 1984) may be recruited to support the derivation of these models.

iii) *Statement of User Needs Stage*. This stage summarises the conclusions of extant systems analysis (e.g. the rationale for recruiting particular extant features to the target system), and defines more specific user requirements, performance criteria and domain semantics for the target system. This design stage may be supported by techniques for performance specification and semantic analysis (e.g. scenario analysis, Malin et al, 1991).

iv) *Composite Task Model Stage*. This stage is concerned with the generation of a conceptual design of the target system. Appropriate parts of the generalised task models described above are synthesised and extended to support function allocation between the human and the computer. Existing function allocation techniques (e.g. Clegg et al, 1989) may be recruited to support this design stage.

v) *System and User Task Model Stage*. The scope of this stage comprises the detailed design of target system functions and job design. Further decomposition of the composite task model is performed to establish information flows between the user and the computer and on-line and off-line descriptions are generated. To support task decomposition, techniques recruited at the preceding stage may also be applied.

vi) *Interaction Task Model Stage*. This stage is involved with device level specifications of the tasks to be performed by the user. Prototyping, simulation, and evaluation techniques may be recruited to support this design stage.

vii) *Interface Model Stage*. The scope of this stage comprises the detailed specification of screen objects, their appearance and behaviours, and recruits techniques such as metaphor analysis, visual display analysis and so on.

viii) *Display Design Phase*. This stage is concerned with the specification of screen contents and layouts, the compilation of a glossary of screen objects, and the definition of



contexts for triggering error and feedback messages. Techniques recruited at the Interaction Task Model Stage may also be applied at this stage.

MUSE is designed for use by trained human factors practitioners, and does not include substantive knowledge (such as human factors guidelines), since practitioners using the method are assumed to already have such knowledge, and know how to apply it.

The next section describes the particular configuration of MUSE used here.

### 3. MUSE Configuration

As discussed in Chapter 1 and Chapter 3, the aim of the analysis reported in this thesis is to construct requirements for the redesign of an existing Accident and Emergency Healthcare Information System from two different paradigm perspectives. This section outlines the specific configuration of the MUSE method that was employed to achieve this aim from the perspective of the postpositive paradigm as represented by the discipline of human factors.

This configuration essentially draws upon the Extant Systems Analysis (ESA) Stage, the Generalised Task Model (GTM) Stage, and the Statement of User Needs (SUN) Stage of the method. A rationale is provided below for the selection of method products, included in each stage of the method, as it is applied in this study.

#### 3.1. Outline Configuration of the Extant Systems Analysis Stage

This section summarises and outlines the ESA products derived in this study. Further details are provided in Section 4.

During the ESA phase, extant systems are analysed to provide background information useful to the design of the target system. Typically, the ESA characterises: current user needs and problems; the allocation of functions between users and devices; and interface design features and their associated rationale. This information is processed into a number of products that provide various perspectives on the design of the target system.

According to Lim and Long (1994), two primary products are typically derived for each extant system analysed. First, a structured diagram description of the extant system is derived by decomposing super-ordinate tasks into sub-tasks. In most cases, a single extant Task Description (TD(ext)) is derived by collating information elicited from task performers and so on. To this end, a basic set of task descriptors (e.g. objects and actions that are common across the information sources) are defined by *generification*. Second, a Generalised Task Model for the Extant System (GTM(ext)) is *abstracted* from the Task Description (TD(ext)). The objective is to remove device dependent details to reveal the logic underlying the system task, to support human factors analysis of extant system designs, and to identify promising features that may be ported to the target system.

In addition to these two key products, other ESA Stage products may also be derived according to individual project circumstances. Lim and Long suggest that a full complement (comprising products for all subsequent stages of the method) may be derived if the extant and target systems are expected to be very similar (as in variant design). However, it is uncommon for all extant system information to be relevant to target system design, and consequently a more specific scope of extant systems analysis is typically identified by comparing the Extant Generalised Task Model (GTM(ext)) with the Generalised Task Model of the Target System (GTM(y)). As we will see in Section 4.2.1, in the current study, a comparison of the GTM(y) with the GTM(ext) suggested the need to derive additional ESA products. In particular, given the expected similarities between the extant and the target systems it was considered necessary to develop a comprehensive Extant Domain of Design Discourse (DoDD(ext)), and to provide lower level *decompositions* of extant designs to further *evaluate* extant design features. These lower-level decompositions comprised an Extant System Task Model (STM(ext)), and an Extant User Task Model (UTM(ext)), which described the user's on-line (i.e. computer supported) and off-line (i.e. manual) tasks for the extant system.

A summary of the products constructed during the ESA Stage in this particular instance is shown in Figure 5.1. In the figure, products marked with a '\*' comprise a subset of the original descriptions which have been identified as being most relevant to the target system (e.g. GTM\*(ext) is a subset of GTM(ext), and so on).

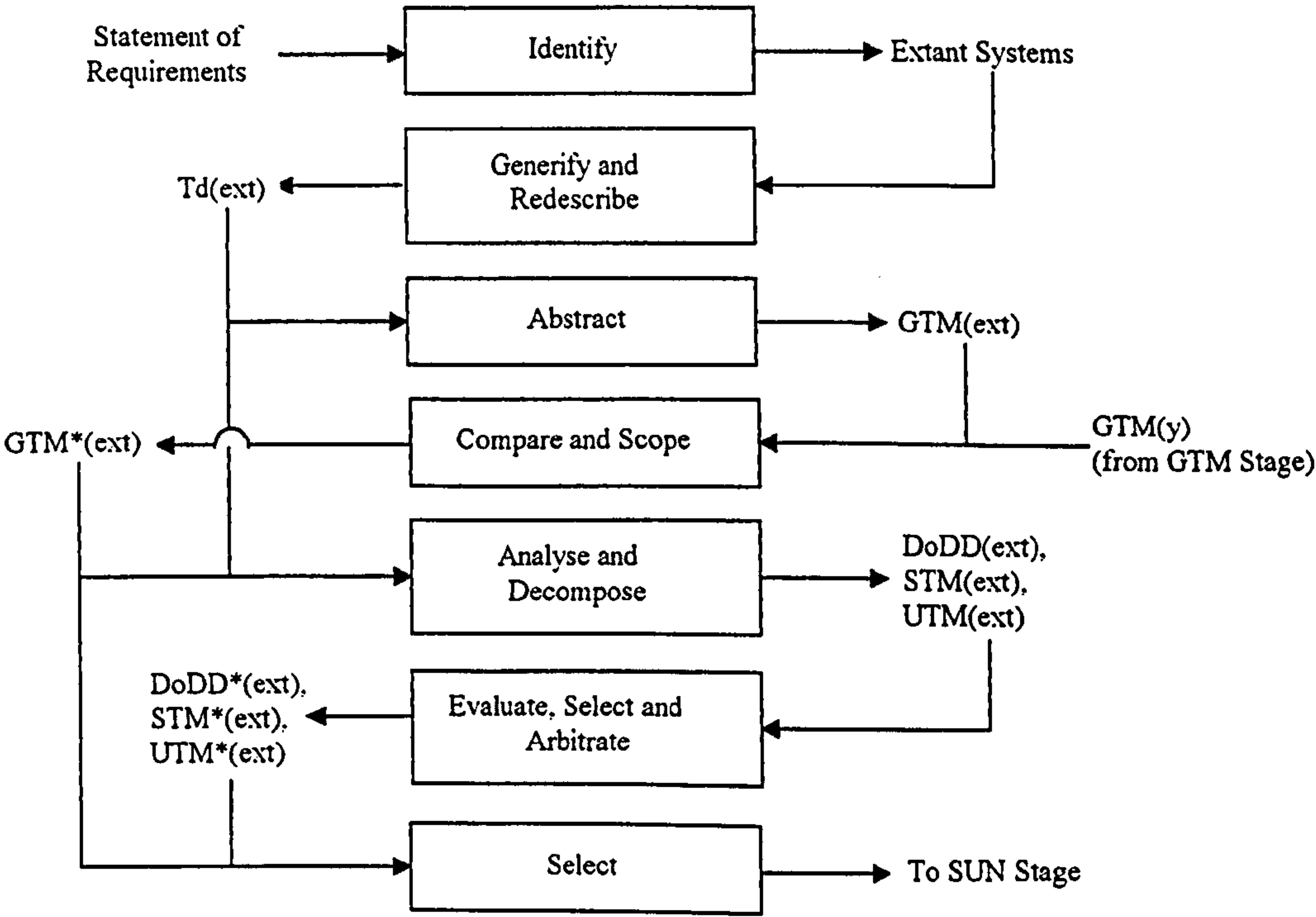


Figure 5.1: Configuration of the ESA Stage for the Current Study



### 3.2. Outline Configuration of the Generalised Task Model Stage

The second stage of the method, the Generalised Task Model Stage, is concerned with the derivation of human factors descriptions to support the conceptual design of the target system. Typically, two models are developed to facilitate: the identification of new design features to support task extensions appropriate to the target system; and the recruitment of relevant design features of the extant system. These models are, respectively: the Target Generalised Task Model, the GTM(y); and the Extant Composite Task Model, the CTM(x). These two models are considered below.

To derive a Target Generalised Task Model (GTM(y)), the initial statement of requirements is *analysed* to identify important details of the target system task. These details are then *abstracted* to derive a conceptual level description.

Following the definition of the GTM(y), a promising set of Extant Generalised Task Models (GTM(ext)s) may be synthesised to derive a composite representation. However, such synthesis is only necessary if more than one extant system has been analysed. In the current study, only one extant system was analysed, and therefore, the Extant Composite Task Model (CTM(x)) in this instance is equivalent to the Extant Generalised Task Model (GTM(ext)).

A summary of the products produced during the GTM Stage in this particular instance is shown in Figure 5.2.

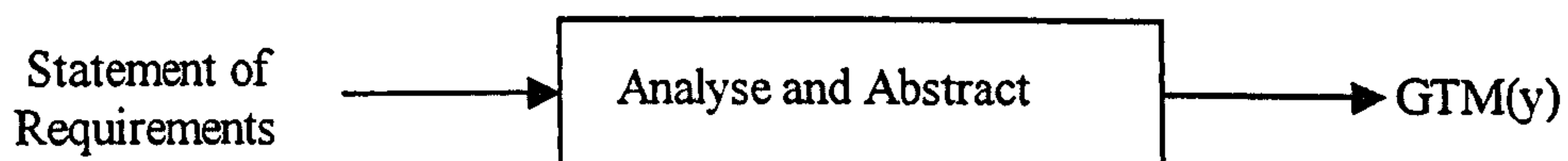


Figure 5.2: Configuration of the GTM Stage for the Current Study

### 3.3. Outline Configuration of the Statement of User Needs Stage

The Statement of User Needs (SUN) Stage summarises the conclusions of the extant systems analysis and defines requirements for the target system. Thus, the information collated typically includes a mixture of the following:

- a) existing user needs and problems
- b) existing design requirements, rationale, and constraints
- c) rationale underlying extant design features to be ported to the target system
- d) performance criteria and domain semantics for the target system

The Target Statement of User Needs (SUN(y)) is derived by *collating* and *re-describing* design information from an initial statement of requirements, and *arbitrating* between and *synthesising* the products derived in the preceding stages of the method (in this case the Extant Systems Analysis and the Generalised Task Model Stages). A summary of the

products collated, re-described, and synthesised during the SUN Stage in this particular instance is shown in Figure 5.3.

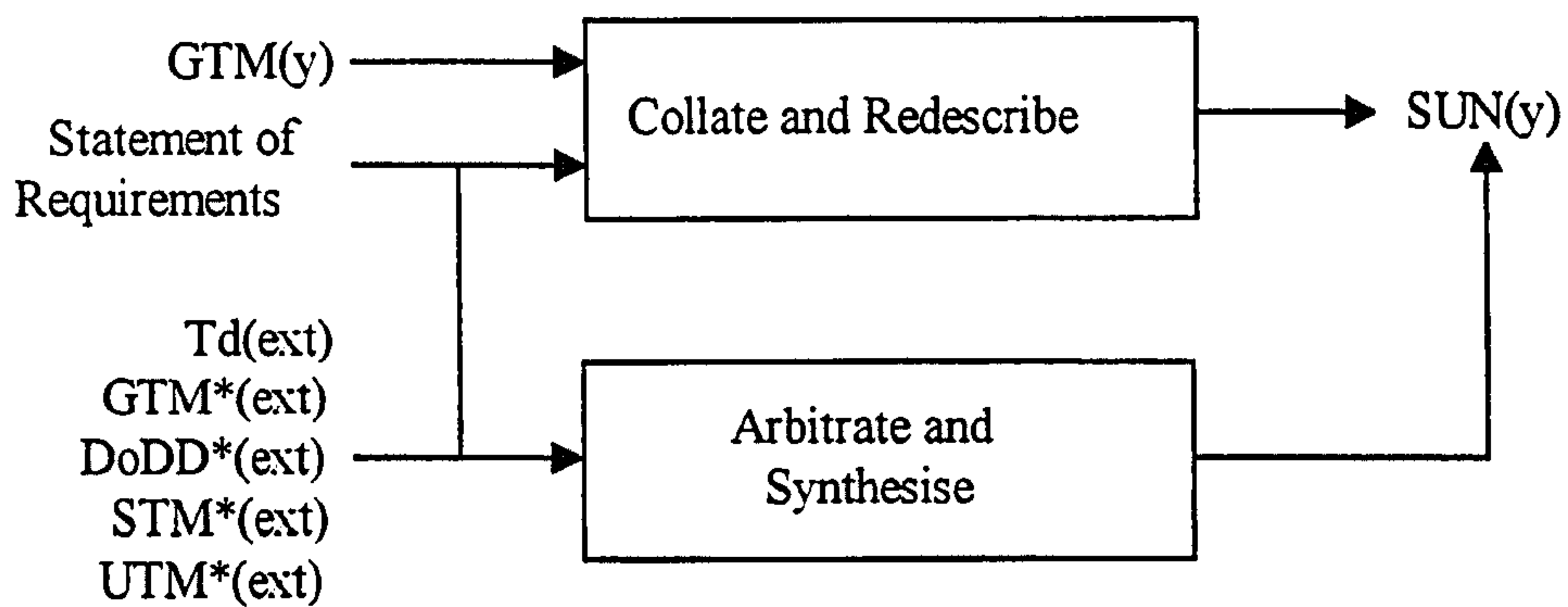


Figure 5.3: Configuration of the SUN Stage for the Current Study

Lim and Long (1994) suggest that, as a rule, the Target Statement of User Needs comprises a textual description that should address the following:

- a) user requirements, general design constraints and performance criteria associated with the target system
- b) user problems with the existing system uncovered by human factors assessments at the ESA Stage
- c) human factors design recommendations and potential solutions to existing problems described in b) above
- d) promising features of extant designs and the rationale underlying their potential recruitment to the design of the target system

In Section 4, we will provide concrete examples of how factors a), b) and c) can be incorporated in textual descriptions, which (at least informally) map onto our current purpose (that is, to identify performance requirements for the target system, through the identification of problems associated with existing system tasks). Factor d) is not included in this mapping, since it is most applicable to the porting of design features to subsequent stages of the MUSE method.

## 4. Applying MUSE to Construct Interactive System Requirements for an A&E Healthcare Information System

This section outlines the application of the configuration of the MUSE method in the analysis of an Accident and Emergency Healthcare Information System.

### 4.1. Extant Systems Analysis (ESA) Stage: Part 1

As described in Section 3, the ESA analysis of the A&E worksystem was conducted in two parts. The first part, developed two primary products, namely the extant Task



Description (TD(ext)) and the Generalised Task Model for the Extant System (GTM(ext)). The second part was conducted in the light of the construction of the Generalised Task Model of the Target System (GTM(y)), which suggested that further ESA products were required (namely, the Extant Domain of Design Discourse (DoDD(ext)), the Extant System Task Model (STM(ext)), and an Extant User Task Model (UTM(ext)).

The extant system analysed here is the A&E department, described in Chapter 4. No related systems were analysed (that is, no other A&E departments in other hospitals), since the hospital at which the research was carried out was the developers' only site of this sort, and it was not possible to arrange access to other hospital sites (especially since extensive analysis of complex systems of this sort demands considerable co-operation on the part of the hospital and its staff). Examining other bespoke A&E computer systems off-site by purchasing them for the purposes of analysis was also not possible due to their high cost.

At this stage, a statement of requirements was obtained informally from the client. Briefly, the client was concerned that the existing computer system did not adequately support the communication of clinical information in the early assessment of patients. In particular, they were concerned with the communication of triage information, and information about investigations.

On the basis of this information, it was decided to examine these two aspects of the department's work in detail, and to touch upon other functions such as diagnosis and treatment only to the extent they rely on information about triage and investigations. It was also decided to concentrate on a single type of investigation, a pathology investigation, which involved the analysis of a blood sample by the haematology lab. The pathology investigation was felt to be broadly representative of investigations in general (with the exception perhaps of X-ray).

Having selected and scoped the extant system to be analysed, information was elicited to support the generation of ESA stage products (the data collection techniques used in this study are described in detail in Chapter 4 and will not be further discussed here).

The ESA products constructed during this analysis (as outlined in Section 3 above) are described in detail below.

#### 4.1.1. Generic Task Description of the Extant System(Td(ext))

Td(ext) is a device-dependent description of the extant system in terms of the tasks it performs, and a characterisation of the allocation of functions between the device and the user.

The extant task description provided here was generified from the analysis of the interview transcripts described in Chapter 4 (a sample of which is provided in Appendix 6). During the generification process, a list of objects and actions was identified for each transcript. These lists were collated, and any duplication was removed. Similar objects and

actions were then grouped, and a generic descriptor for them was generated. These generic terms were then used to re-describe individual task descriptions generated from the transcripts. During the analysis, attention was paid to the identification of user needs and problems, and the rationale underlying extant system designs.

A Td(ext) is described using structured diagrams, and an accompanying information table that provides a textual account of salient features of the task<sup>27</sup>. In the analysis described below, the Td(ext) is broken down into three segments for convenience of presentation, these segments are: triage; investigation requests; and investigation results. The Td(ext) is shown in Figures 5.4 - 5.6, and Tables 5.0 - 5.2.

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<sup>27</sup> These are the default notations used in MUSE.



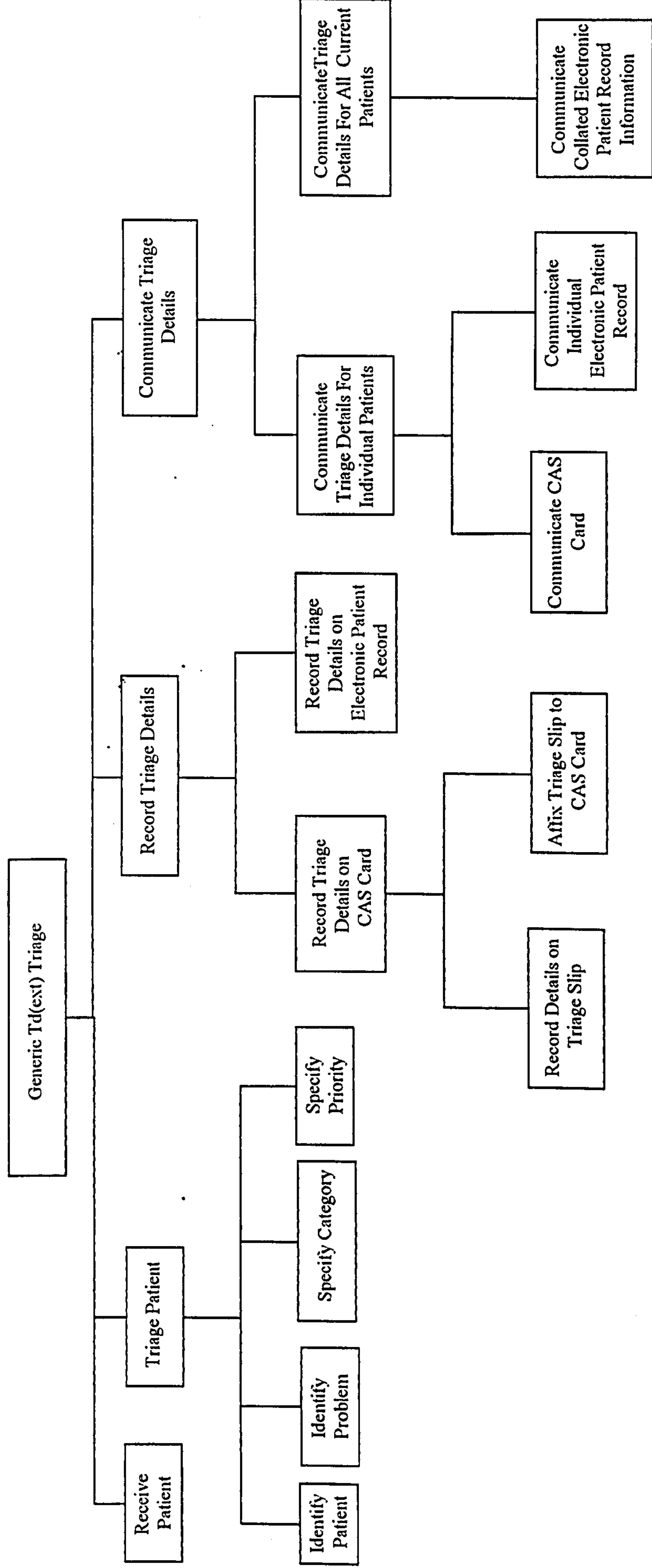


Figure 5.4: Generic Extant Task Description (Td(ext)) for A&E Worksystem (Triage)

Name	Description	Observation	Design Implication	Speculation
Record Triage Details on CAS Card	A manual record of triage assessment is made.	The CAS card is the main means of communication about individual patient details.	The CAS card offers a convenient way to collate patient information, and is highly portable.	It is unlikely, in the foreseeable future, that the department would consider wholly electronic versions of patient information.
Record Triage Details on Triage Slip	Triage nurses record their assessment in real-time during their interaction with the patient. This assessment is hand-written on a sticky label.	Nurses spend considerable time formulating descriptions of the patient's presenting problem.	Time may be reduced if problem descriptions were based on standard clinical descriptions.	Computer-based clinical thesauri are used elsewhere in the hospital. Consider use of such tools to support triage nurses.
Record Triage Details on Electronic Patient Record	The results of the triage are also typed into the computer system by triage nurses.	This task appears to distract from the assessment of patients, and may cause delays. It can be left until there is a quiet moment available, but is part of a critical path insofar as in most cases CAS cards cannot be taken by nurses in the treatment areas until the information has been copied onto the computer system. The time taken in copying data can be excessive.	Triage nurse workload with respect to the recording of triage data is high, and should be reduced.	This task (and its relationship to manual recording) should be examined in more detail.
Communicate Triage Details for Individual Patients	This task is primarily achieved by the manual transfer of a CAS card from triage to the appropriate treatment area. It is essentially a way of communicating triage information about individual patients to the doctors.  However, sometimes triage information has to be provided more generally (e.g. to relatives making a telephone enquiry about a patient), and so an electronic version is provided to allow any nurse to find out some basic details about a patient's condition (such as its nature, seriousness, etc.) without having to have access to the CAS card.	The provision of an electronic version of triage information is very popular with nursing staff, and is recognised to save considerable amounts of time when answering telephone enquiries from relatives.	Physical and electronic versions of triage data should both be retained.	
Communicate Collated Electronic Patient Record Information	This task communicates collated triage information for all current patients	This information is mostly only accessed by sisters and charge nurses to monitor the status of the department. It is not used by the more junior nurses to organise their work. For example, nurses monitor the number of CAS cards accumulating in the triage nurses out-trays to get an indication of the number of patients waiting to come into their area. This tells them nothing about priorities or types of patients to expect.	Collated computerised triage information appears to be ineffective.	It may be that either the right type of information is not being provided, or that it is hard to access given the time constraints acting on treatment area nurses.

Table 5.0: Generic Extant Task Description (Td(ext)) - Triage



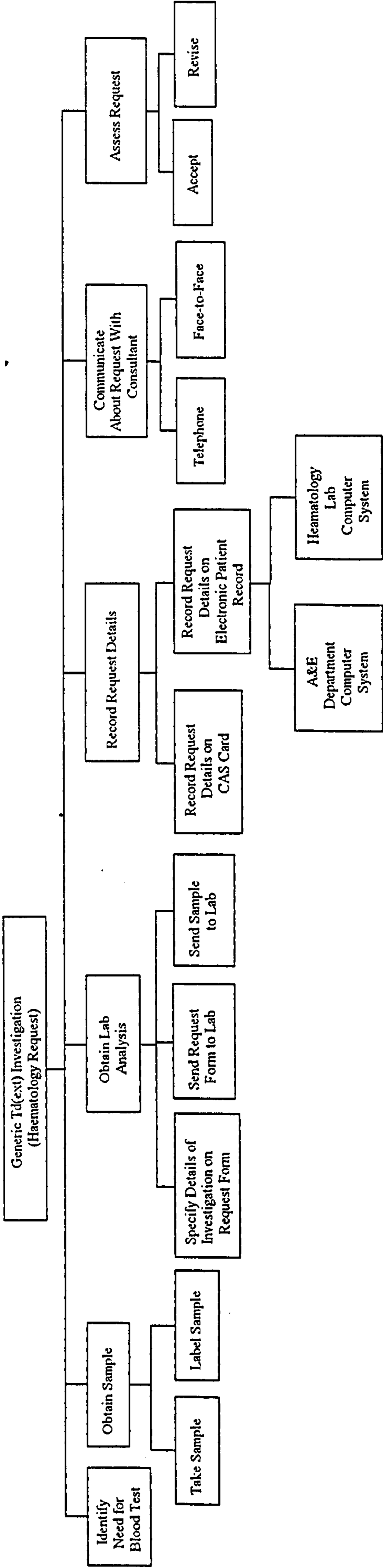


Figure 5.5: Generic Extant Task Description (Td(ext)) for A&E Worksystem (Investigation Request)

Name	Description	Observation	Design Implication	Speculation
Specify Details of Investigation on Request Form	The doctor writes an investigation specification on a formal request form.			
Send Request Form to Lab	This is a manual task carried out by the treatment area nurses.			This task should be examined in more detail to identify possible alternative ways of communicating the request to the labs.
Record Investigation Request Details on CAS Card	The doctor writes the details of the investigation request on the patient's CAS card.	This is a duplication of the specification task performed earlier.	Redundancy	
Record Investigation Details on Electronic Patient Record	Two versions of the same information are made.		Further redundancy.	The computer systems in A&E and the labs should be compatible and networked together.
1. A&E Department Computer System	The clerks responsible for post-disposal copy the investigation request details from the CAS card onto the A&E system.	This task takes place after the patient has left the A&E department.	Use of both electronic versions of the request restricted to post-hoc clinical and managerial analysis.	Consider scope for earlier creation of a single digital specification to support real-time clinical tasks and reduce redundancy.
2. Haematology Lab Computer System	The lab technicians copy the investigation request details from the request form to their computer system.	This task duplicates the task of the doctor specifying the request.		
Communicate About Request With Consultant	This task allows a doctor to take expert advice on an investigation specification.	The doctor may be able to meet with the consultant face-to-face, but more often telephones to discuss the investigations specification.  Investigation specifications may be complex, and particularly in the case of telephone communication, the medium in which the specification is presented (i.e. speech) may result in ineffective assessments (because of misunderstandings or interpretation errors).	Consider, supporting the communication of textual investigation specifications.	Consider synchronous or asynchronous textual communication.
Revise Investigation Request	This task allows the doctor to revise his investigation request.	Requests may have to be rewritten.		Allow doctors to amend digital specifications.

Table 5.1: Generic Extant Task Description (Td(ext)) - Investigation Request



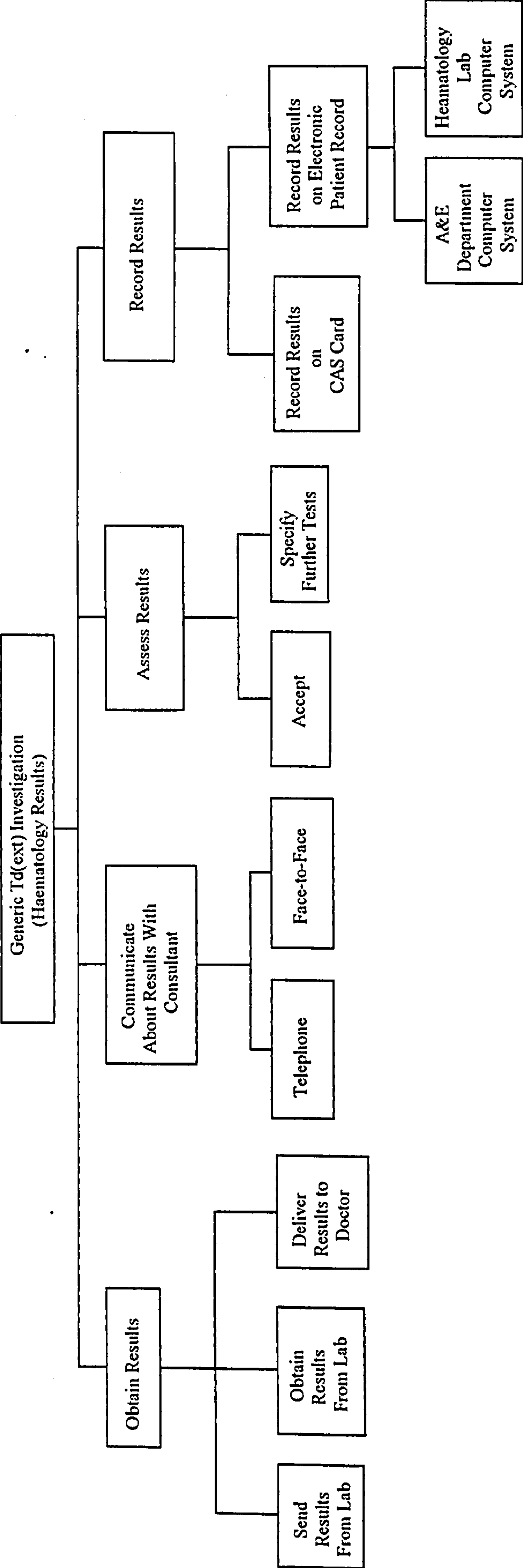


Figure 5.6: Generic Extant Task Description (Td(ext)) for A&E Worksystem (Investigation Result)

Name	Description	Observation	Design Implication	Speculation
Send Results From Lab	The results of the lab analysis of a sample are sent to the A&E department.	The results of the analysis are faxed from the lab.	Results may be untimely.	This task should be examined in more detail to identify possible alternative ways of communicating results (e.g. on-line).
Retrieve Results From Lab Deliver Results to Doctor	The results of the lab analysis are retrieved by nurses, and conveyed to doctors.	Collecting faxes interferes with the flow of work in the treatment area.	Results may be untimely.	This task should be examined in more detail to identify possible alternative ways of communicating results e.g. on-line).
Record Results on Electronic Patient Record	Two versions of the same information are made.		Redundancy.	The computer systems in A&E and the labs should be compatible and networked together.
1. Haematology Lab Computer System 2. A&E Department Computer System	Automatic generation of digital results by analysis computer. Clerks copy print out (fax) of results onto A&E computer system.	Hard copy produced for A&E	Digital results from lab analysis computer should be fed directly to A&E system.	Consider verification procedures.
Communicate About Request With Consultant	This task allows a doctor to take expert advice on investigation results.	The doctor may be able to meet with the consultant face-to-face, but more often telephones to discuss the investigation results.  Investigation results may be complex, and particularly in the case of telephone communication, the medium in which the results are presented (i.e. speech) may result in ineffective assessments (because of misunderstandings or interpretation errors).	Consider, supporting the communication of textual investigation results.	Consider synchronous or asynchronous textual communication or shared screens.
Revise Investigation Request	This task allows the doctor to revise his investigation request.	Requests may have to be rewritten.		Allow doctors to amend digital specifications.

Table 5.2: Generic Extant Task Description (Td(ext)) - Investigation Result



### 4.1.2. Generalised Task Model of the Extant System

The objective of an Extant Generalised Task Model, or GTM(ext), is to expose the logic underlying system tasks, and provide a conceptual analysis of the extant system relative to the requirements of the target system. To this end, the GTM (ext) provides a more abstract device-independent description of the extant system by removing those elements of the Td(ext) descriptions that are device-specific.

The extant task description for the A&E system was processed into an Extant Generalised Task Model (shown in Figures 5.7, 5.8 and 5.9). Device-specific information was removed. For example, for the A&E system, 'Specify Details of Investigation on Request Form' was reduced to a single description 'Specify Details of Investigation Request'. Also, some lower level details of the Extant Task Description were omitted to produce a more general description. For example, a distinction between the electronic patient record as recorded on the A&E system and that recorded on the haematology lab computer system was not maintained. However, given the expected similarities between the target system and the extant system some device-dependent features were retained. In particular, as noted in the Td(ext) tables, a manual system of recording patient information (in the form of the CAS card) would be retained alongside any electronic patient records for the foreseeable future, and this fact is reflected in the GTM(ext).

A new set of design information tables was not generated, since interpretation of the Extant Generalised Task Model was supported adequately by the tables accompanying the extant task descriptions.

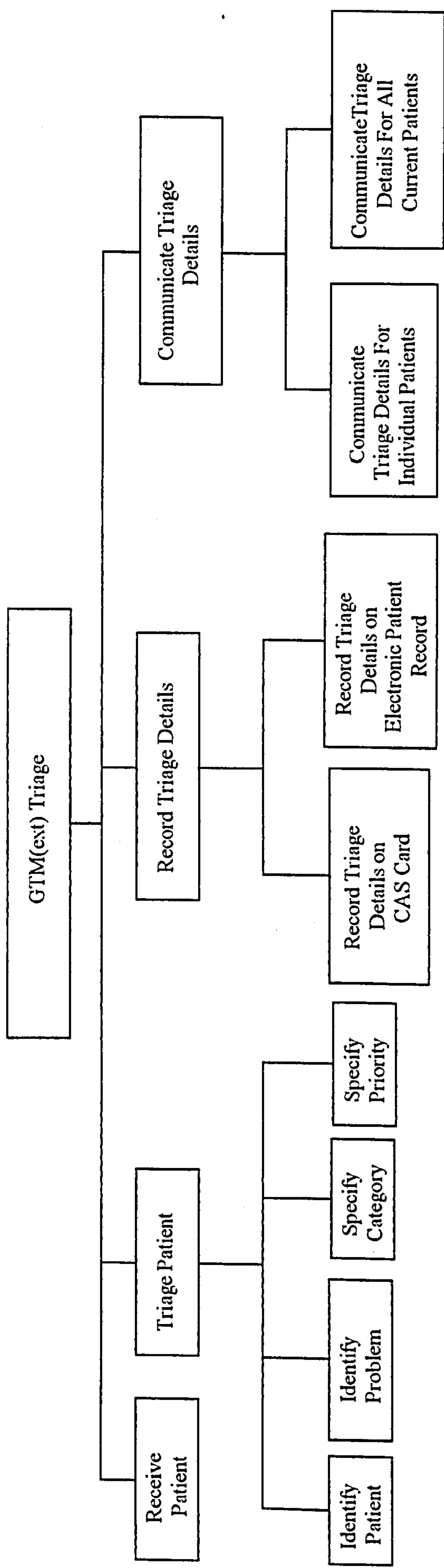


Figure 5.7: Generalised Extant Task Description (GTM(ext)) for A&E Worksystem (Triage)



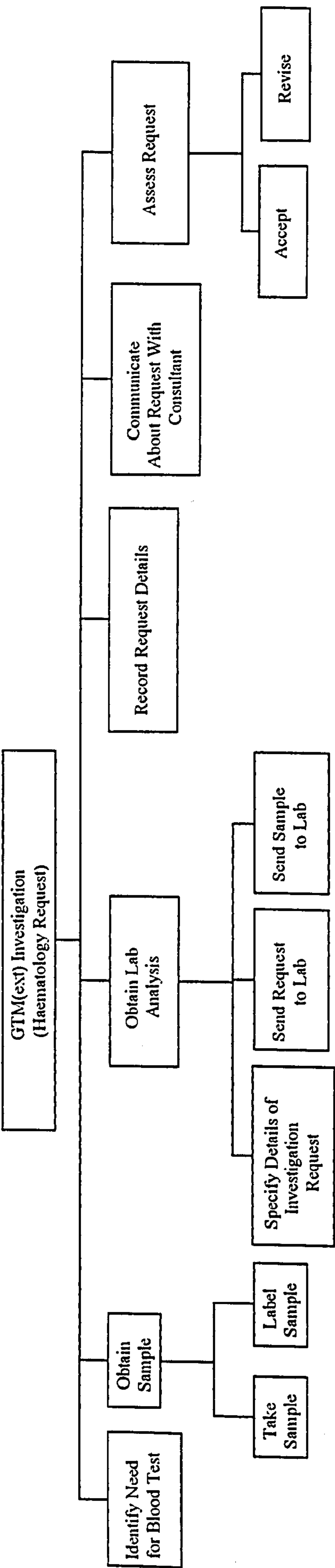


Figure 5.8: Generalised Extant Task Description (GTM(ext)) for A&E Worksystem (Investigation Request)

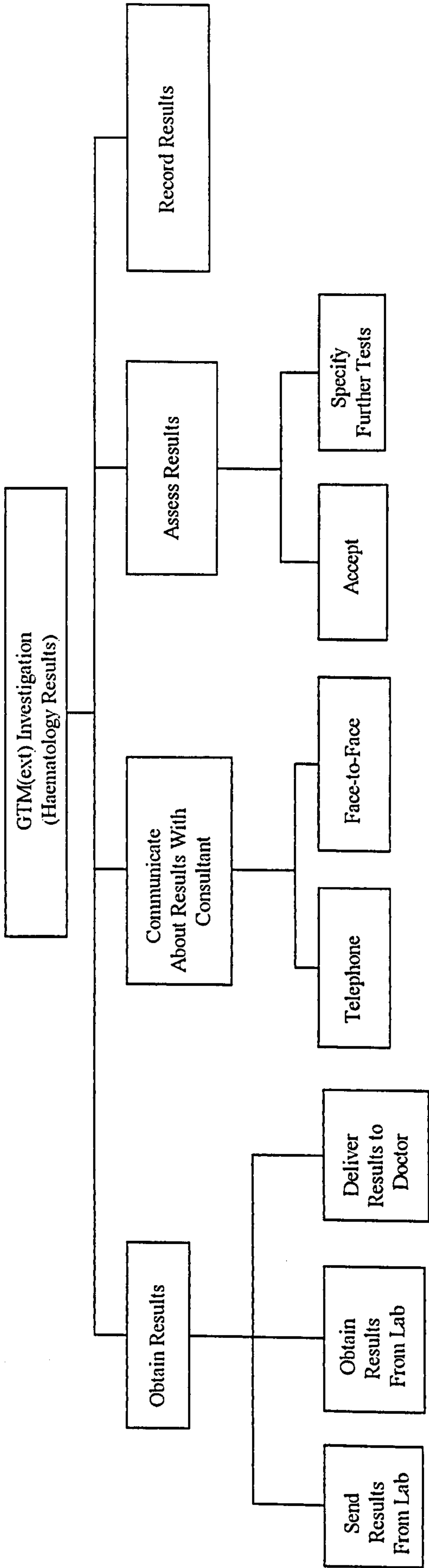


Figure 5.9: Generalised Extant Task Description (GTM(ext)) for A&E Worksystem (Investigation Results)



## 4.2. Generalised Task Model (GTM) Stage

As described in Section 3.2, this Stage of the method is concerned in this instance with the generation of the Target Generalised Task Model, the GTM(y).

### 4.2.1. Target Generalised Task Model (GTM(y))

The GTM(y) represents the first attempt at defining a conceptual design for the target system, and defines the scope of its tasks and identifies possible new features. The GTM(y) is derived by analysis of the client's statement of requirements. Details of the target system's tasks are identified, and then abstracted to derive a conceptual level of description.

As indicated in Section 4.1, the statement of requirements from the client indicated a concern that the existing computer system did not adequately support the communication of clinical information in the early assessment of patients. A GTM(y), based on this statement of requirements, is shown in Figure 5.10. Associated notes are provided in Table 5.3.

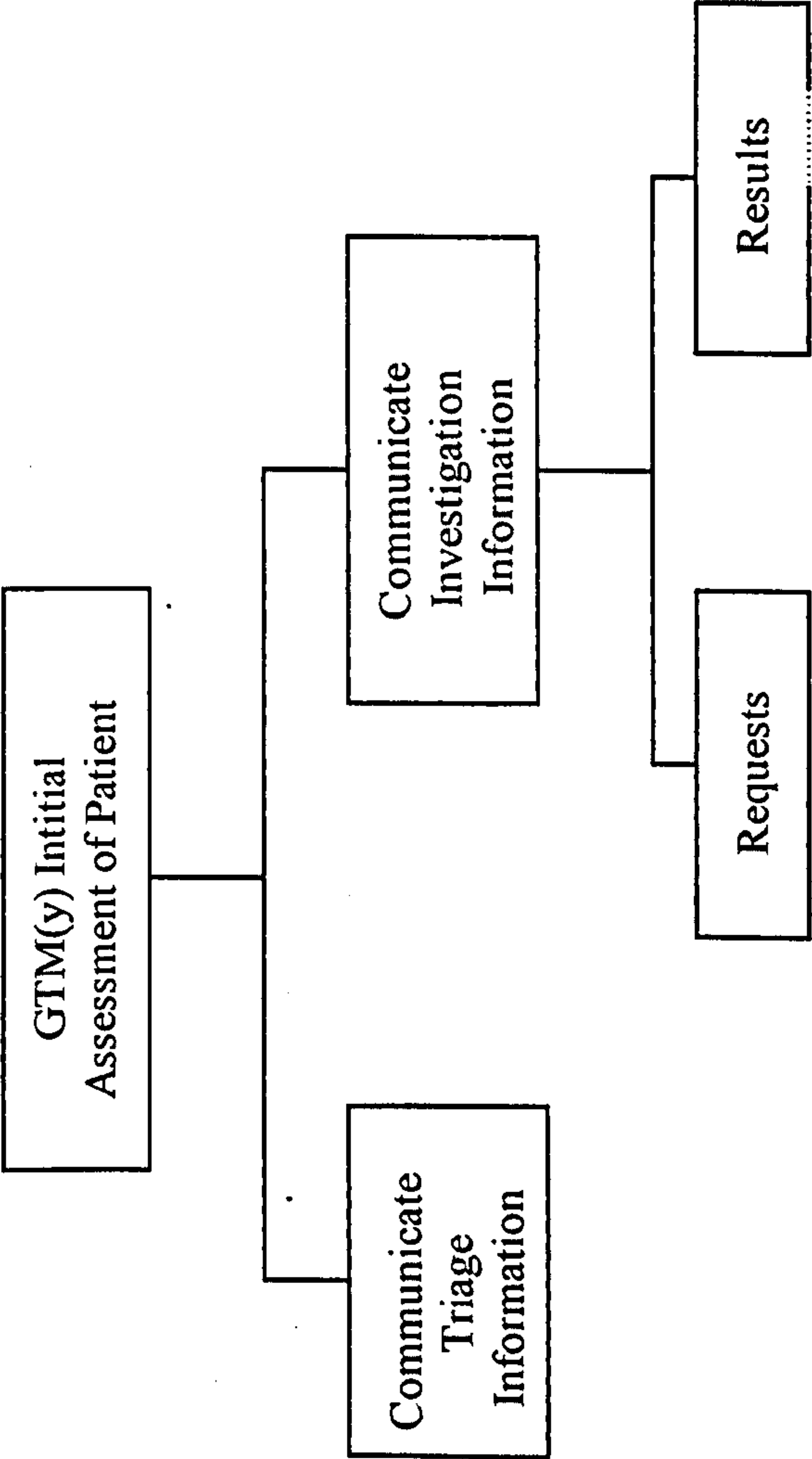


Figure 5.10: Generic Target Task Description (GTM(y)) for A&E Worksystem



Name	Description	Observation	Design Implication	Speculation
Communicate Triage Information	Triage information is used for various purposes, including: prioritisation of patients; management of resources; supporting diagnosis; and hospital statistics.	<p>The client highlighted possible purposes for triage information, but focused in particular on its current use in patient prioritisation and hospital statistics.</p> <p>The client has focused on communication, but has ignored how triage information is obtained and recorded prior to communication.</p>	Consideration of the use of triage information in the management of resources would be appropriate.	There is a potential relationship between the use of triage information as used for prioritising patients and that used for the management of resources.
Communicate Investigation Requests	Investigation requests are communicated between the A&E department and the laboratories.	<p>The client felt that the current communication system did not fully exploit the potential of computer support, but no specific problems with the current task were expressed.</p> <p>The client has focused on communication, but has ignored how investigation requests are prepared and recorded prior to communication.</p>	Digital support would be acceptable to the client for these communication tasks.	Digital information exchange may also have an impact on record-keeping activities during post-disposal.
Communicate Investigation Results	Investigation results are communicated between the laboratories and the A&E department.	<p>The client felt that the current communication system did not fully exploit the potential of computer support, but no specific problems with the current task were expressed.</p> <p>Once again, the client has focused on communication, but has ignored how investigation results are prepared and recorded prior to communication.</p>	Digital support would be acceptable to the client for these communication tasks.	Digital information exchange may also have an impact on record-keeping activities during post-disposal.

Table 5.3: Generic Target Task Description (GTM(y)) for A&E Worksystem

### 4.3. Extant Systems Analysis (ESA) Stage: Part 2

As indicated in Section 4.1, the client’s statement of requirements was brief and left many unanswered questions about the target system tasks. Not surprisingly, then, a comparison of the GTM(y) with the task descriptions previously generated, indicated a need to return to the Extant Systems Analysis Stage to generate more detailed information about the conceptual tasks of the target system.

More particularly, a comparison of the GTM(y) with the GTM(ext) indicated that further information was required about: the semantics of the overall work domain and the desired performance of the system more generally; and the design features associated with lower level tasks.

Additional domain information was provided by the development of a comprehensive Extant Domain of Design Discourse (DoDD(ext)). Additional information about lower level tasks was provided by the development of an Extant System Task Model (STM(ext)), and an Extant User Task Model (UTM(ext)), which described the user’s on-line (i.e. computer-supported) and off-line (i.e. manual) tasks for the extant system.

#### 4.3.1. Extant Domain of Design Discourse (DoDD(ext))

The DoDD(ext) describes the semantics of the extant system domain by identifying explicit relationships between domain entities (comprising domain concepts, domain objects, task events and processes). This description establishes the conceptual scope of the extant system. In general, a DoDD(ext) should only be derived if the target system is expected to be conceptually similar to the extant system. The DoDD(ext) is summarised as a semantic net, comprising nodes and relations which are expanded textually in accompanying table. The DoDD(ext) for the extant A&E system is shown in Figure 5.11 and Table 5.4.

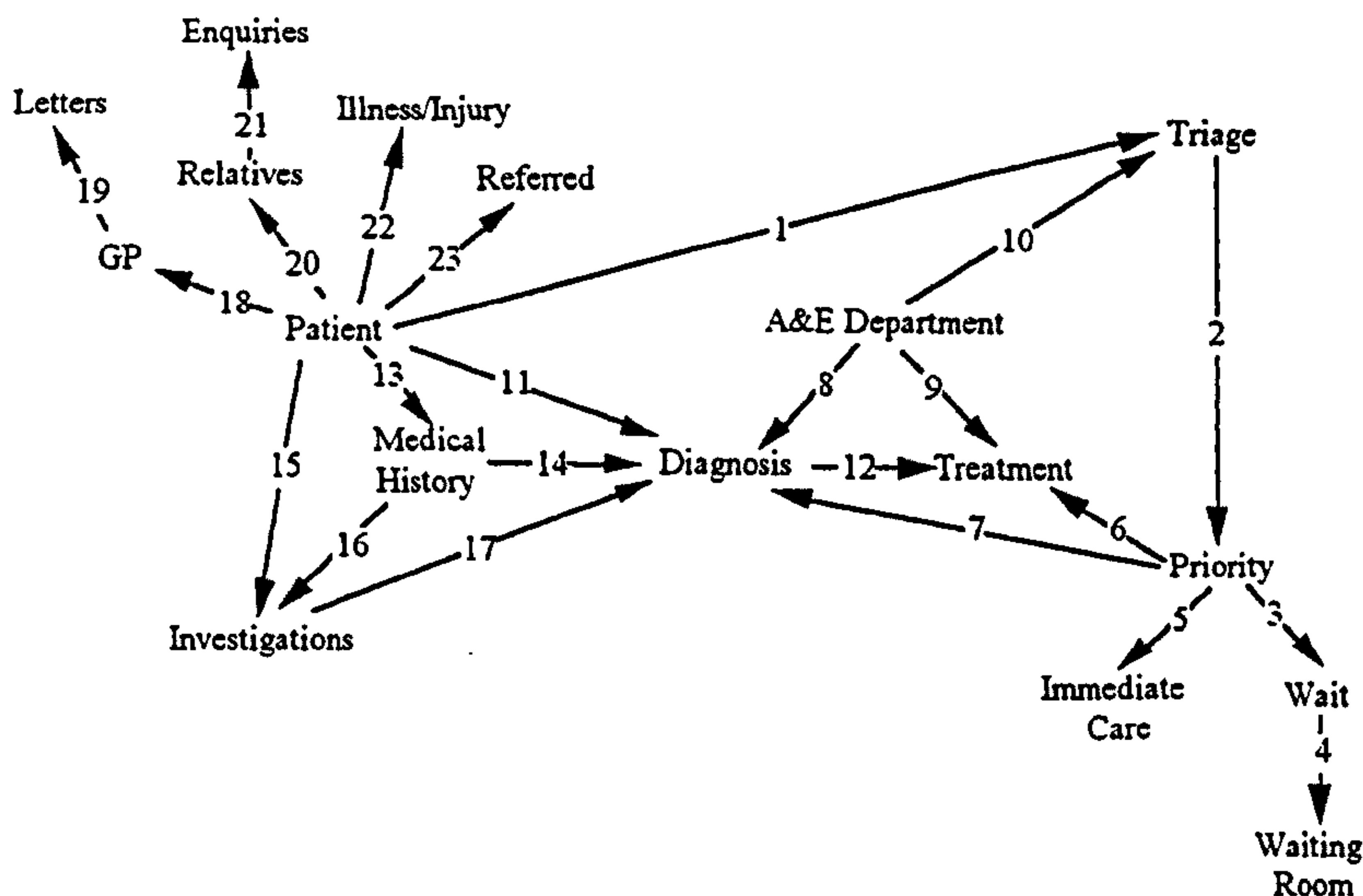


Figure 5.11: Domain of Design Discourse for the Extant System



Relationship Number	Summary of Relationship
1	is always subject to
2	determines
3	results in
4	in the
5	results in
6	determines urgency of
7	determines urgency of
8	provides
9	provides
10	provides
11	desires
12	and
13	has a
14	contributes to
15	may be subject to
16	influences
17	contributes to
18	has a
19	receives
20	has
21	who may make
22	has
23	may be

Table 5.4: Summary of Relationships Between Nodes of the Domain of Design Discourse for the Extant System

The A&E department is represented as single node in the DoDD(ext) described above, but is clearly a complex entity which needs to be understood in more detail. To this end, three additional notations proposed by Lim and Long (1994 - Appendix B) were employed to support the domain of design discourse analysis. These additional notations were as follows:

- a) a semantic net notation (with supporting descriptive table) was used to describe the basic hierarchy of the extant work organisation
- b) a network diagram (with supporting descriptive table) was used to describe the content, direction, and types of information flows between members of the work organisation.
- c) a function flow diagram (with supporting descriptive table) was used to describe high-level organisational goals, and their associated performance parameters

#### 4.3.1.1. Extant Organisational Hierarchy

First, it was considered necessary to describe the basic hierarchy of the work organisation. The description defines basic contextual information that supports the

specification of the worksystem and its sub-systems. For example, basic relationships and information flows between roles are established by the hierarchy. The extant organisational hierarchy is summarised as a variant of a semantic net with an accompanying table (see Figure 5.12, and Table 5.5).

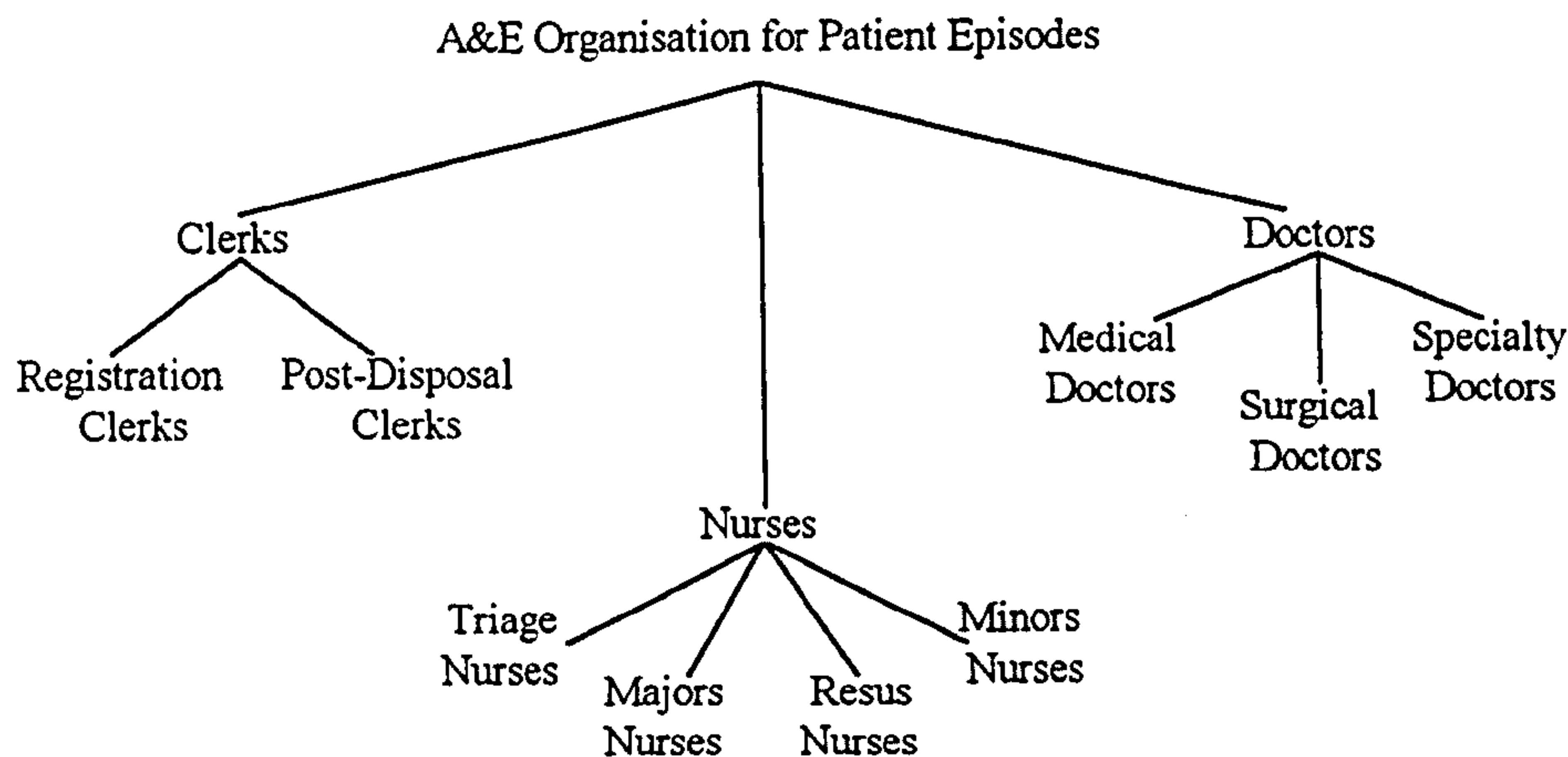


Figure 5.12: Extant Organisation Hierarchy for A&E Department

Staff Member	Basic Responsibilities
Registration Clerk	Take patient details as per the NHS basic data set. Enter data into computer system. Print patient's CAS card.
Post-Disposal Clerk	Ensure that aspects of each patient episode are recorded and collated (both as a paper file, and a computer record).
Triage Nurse	Conduct the initial assessment of the patient on arrival. Prioritise and categorise patients. Triage nurses have special training, and are Grade E and above.
Majors Nurses	Organise patients and resources in the majors treatment area. Carry out treatments and investigations.
Minors Nurses	Organise patients and resources in the minors treatment area. Carry out treatments and investigations.
Resuscitation Nurses	Organise patients and resources in the resuscitation treatment area. Carry out treatments and investigations.
Medical Doctor	Assess, treat and advise patients on medical aspects of their injuries and afflictions (e.g. diagnoses and medications).
Surgical Doctor	Assess, treat and advise patients on surgical aspects of their injuries and afflictions (e.g. diagnoses and procedures).
Specialty Doctor	Assess, treat and advise patients on specialty-specific aspects of their injuries and afflictions (e.g. diabetes).

Table 5.5: Table Associated with the Extant Organisation Hierarchy

4.3.1.2. Extant Information Flow

To further understand the complexities of the work domain, it was considered important to describe the content, direction, and types of information flows between members of the work organisation. The information flows are represented as a network diagram, and details



of the information exchanged is expanded in a supporting table (see Figure 5.13 and Table 5.6).

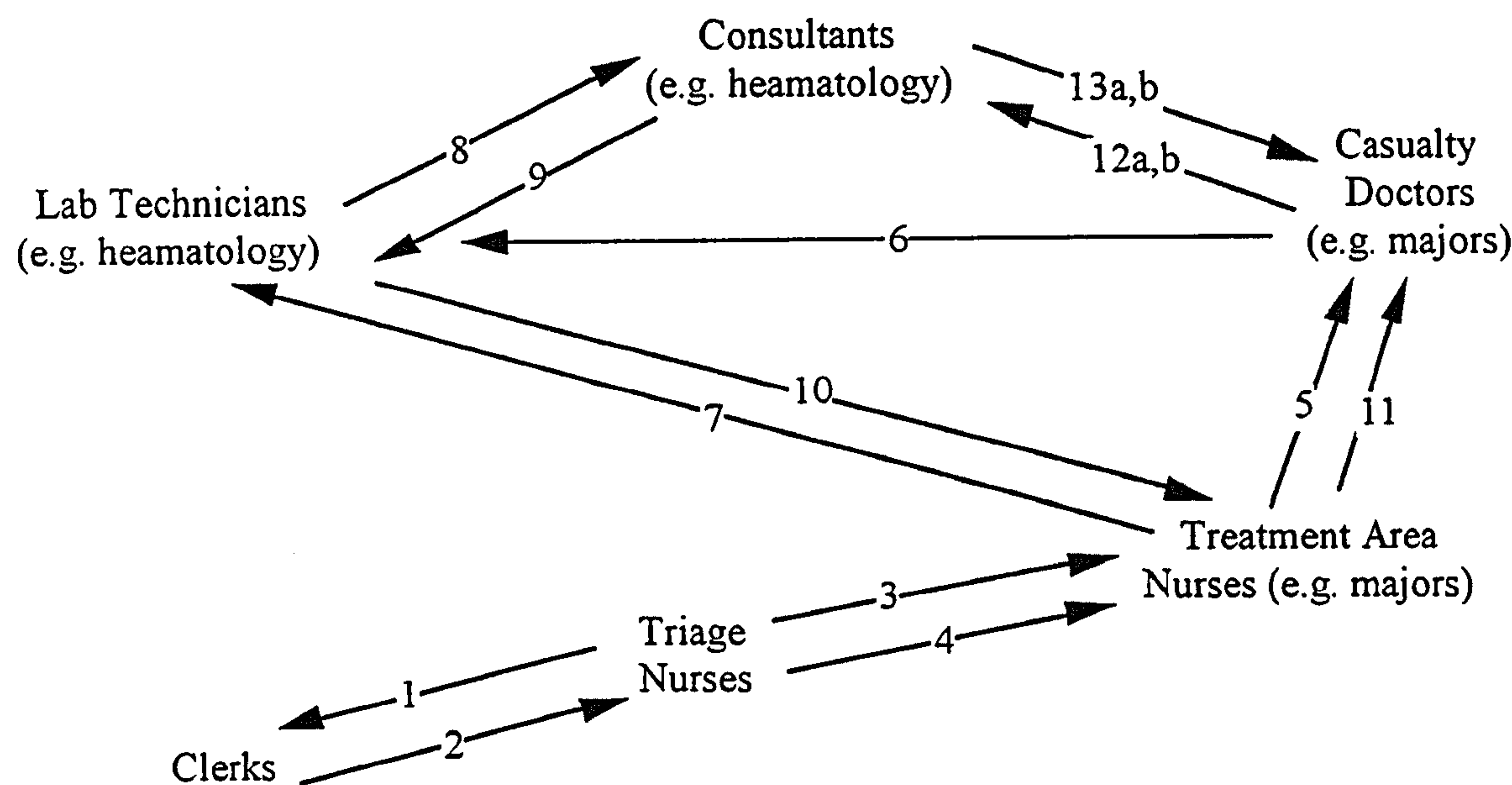


Figure 5.13: Extant Information Flow (Triage and Patient Investigations)

Information Number	Senders/ Receivers and Content Summary
1	The triage nurses provide the clerks with an hand-written sticky label which records the details of their assessment of the patient. This label includes: patient ID; a description of the problem; an assignment of category; an assignment of priority.
2	The clerks provide the triage nurses with a printed CAS card for each patient. Affixed to the CAS card is the triage sticky label.
3	The triage nurse provides the nurses in the treatment areas with CAS cards appropriate to their area.
4	The triage nurse provides the nurses in the treatment areas with triage information that has been entered onto the computer system.
5	Nurses in the treatment areas provide doctors with a patient's CAS card.
6	The doctor sends an investigation request form to the lab technicians (e.g. haematology).
7	The nurse sends the patient's sample to the labs (e.g. a blood sample to the haematology lab).
8	The lab technician provides the consultant with the results of the sample analysis for comment and/or approval.
9	The consultant comments on and/or approves the results.
10	The lab technician sends the results of the investigation to the nurses in the treatment areas.
11	The nurse provides the doctor with the results of the investigation appended to the patient's CAS card.
12	The doctor may send either the investigation request form (a) or the investigation results (b) to the consultant for comment.
13	The consultant sends comments on either the investigation request form (a) or the investigation results (b) to the doctor.

Table 5.6: Table Associated with the Description of Extant Information Flow

4.3.1.3. Extant System Performance

Finally, to contribute to an understanding of the conceptual scope of the extant system, it was considered appropriate to describe the performance criteria for major sub-systems of the extant system. High-level organisational goals are expressed as function modules, and the performance parameters associated with each function module are specified. Function modules are represented as a function flow diagram, and performance criteria are specified textually in an accompanying table (see Figure 5.14 and Table 5.7).

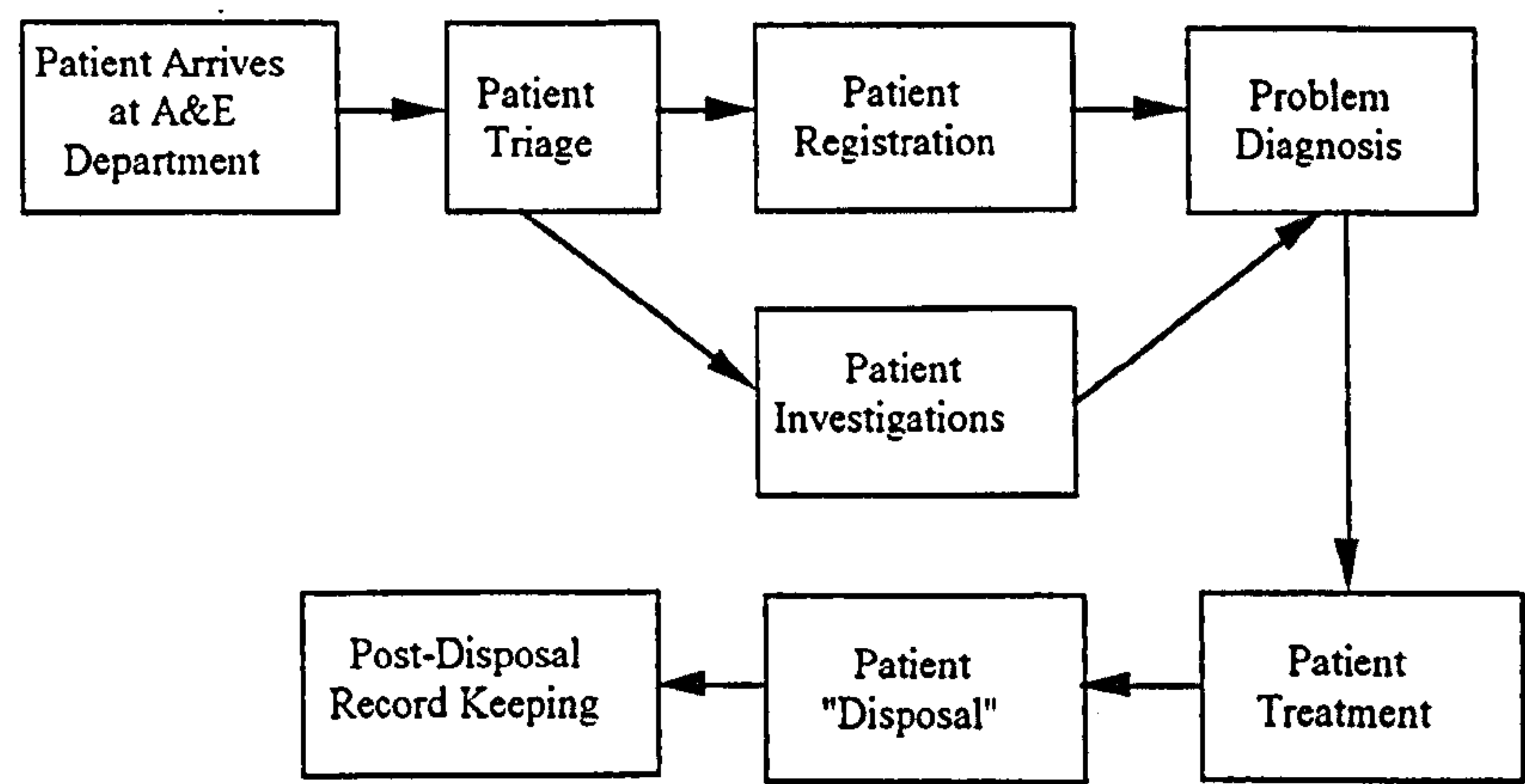


Figure 5.14: Describing System Performance of the A&E Department

Function Module	Performed by	Performance Criteria
Patient Arrival	Patient	Patients (“walking wounded”) should present themselves to the triage desk immediately on arrival in the department.
	Ambulance Personnel	Ambulance personnel should present patients to triage desk (rear) immediately on arrival.
Patient Triage	Triage nurses	Patients must be triaged in less than five minutes.
Patient Registration	Triage nurses	Patient category, priority, and patient ID must be complete; problem description should be complete
	Clerks	NHS basic data set must be complete.
Patient Diagnosis	Doctors	Diagnosis should be accurate.

Table 5.7: Table Associated with the System Performance  
Description of the A&E Department (continued overpage)



Patient Investigations	Doctors	Doctors responsible for specifying, ordering and interpreting investigations. These specifications should be accurate.
	Nurses	Nurses are responsible for taking samples, sending samples and specifications to the labs, and retrieving results from the labs. Nurses must ensure that results are timely.
	Lab technicians	Lab technicians are responsible for analysing samples and returning results to the A&E department. These results should be timely.
	Consultants	Consultants advise on the suitability of specifications and interpretation of results. Their advice should be timely and accurate.
Patient Treatment	Nurses	In the majority of cases, nurses are primarily responsible for the treatment of patients as specified by a doctor. Such treatments should be suitable to both the patient and the doctor.
	Doctors	Procedures that require a doctor for their completion should similarly be suitable to both the patient and the doctor.
Patient Disposal	Nurses	Patients must be disposed accurately to their next location (e.g. wards, home, GP, etc.).
Post-Disposal Record Keeping	Clerks	Clerks complete and maintain records of each patient episode. These records should be accurate and complete.

Table 5.7: Table Associated with the System Performance  
Description of the A&E Department (continued from previous page)

As mentioned in Section 4.3, a comparison of the GTM(y) and GTM(ext) also indicated that further information was required about on-line and off-line tasks of A&E staff with respect to the extant system. In MUSE, on-line tasks of the extant system are characterised by an human factors description termed an Extant System Task Model, or STM(ext). Similarly, off-line tasks are characterised by an human factors description termed an Extant User Task Model, or UTM(ext). These two products are described in the following sections.

#### 4.3.2.Extant System Task Model (STM(ext))

The STM(ext) characterises the on-line task of the extant system in terms of the human computer interaction required. The STM is derived with reference to the GTM(ext), or with reference to the Td(ext), if a more detailed description is required. In this instance, the STM(ext) was derived with respect to the Td(ext). The STM(ext) is shown in Figures 5.15 - 5.18, and Tables 5.8 - 5.11.

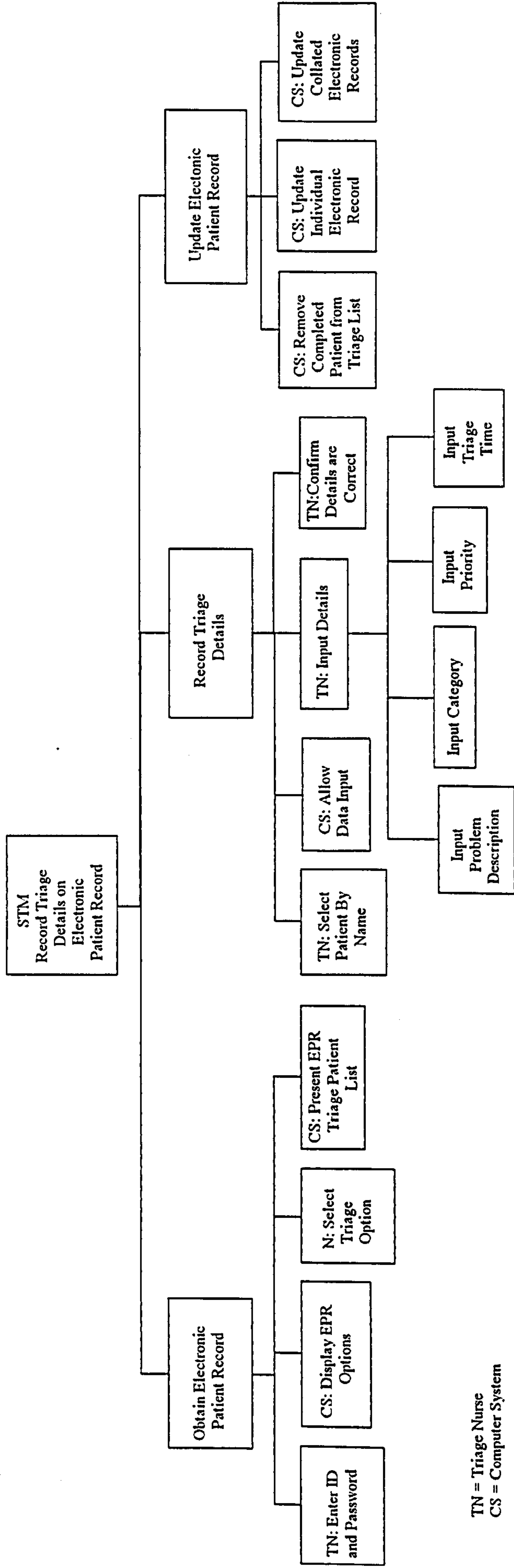


Figure 5.15: Extant System Task Model (STM(ext)) for A&E Worksystem (Record Triage)



Name	Description	Design Speculation
Obtain Electronic Patient Record	Obtaining the Electronic Patient Record follows a standard procedure no matter which terminal is being used. This is to allow for different tasks to be performed at any terminal. Triage nurses, however, only ever use those facilities associated with triage <i>per se</i> .	The triage workstation should default to the EPR triage patient list on log-in . This would substantially reduce the time to complete individual patient details.
TN: Input Details	Details are inputted using pick lists. This is repetitive and time consuming.  Nurses spend considerable time inputting free-text descriptions of the patient's presenting problems.	Triage details might be grouped to allow selection of a scenario rather than individual details. This would reduce data input times, and might, therefore, support a more complete problem description.  Computer-based clinical thesauri are used elsewhere in the hospital, and could equally well support the triage task.
TN: Input Triage Time	The triage nurse inputs the time taken to triage the patient. Nurses have a tendency to input inaccurate triage times, since the pressure on them to perform within specified time limits is intense. This means that hospital statistics are meaningless.	The system should automatically calculate triage times.

Table 5.8: Extant System Task Model (STM(ext)) for A&E Worksystem (Record Triage)

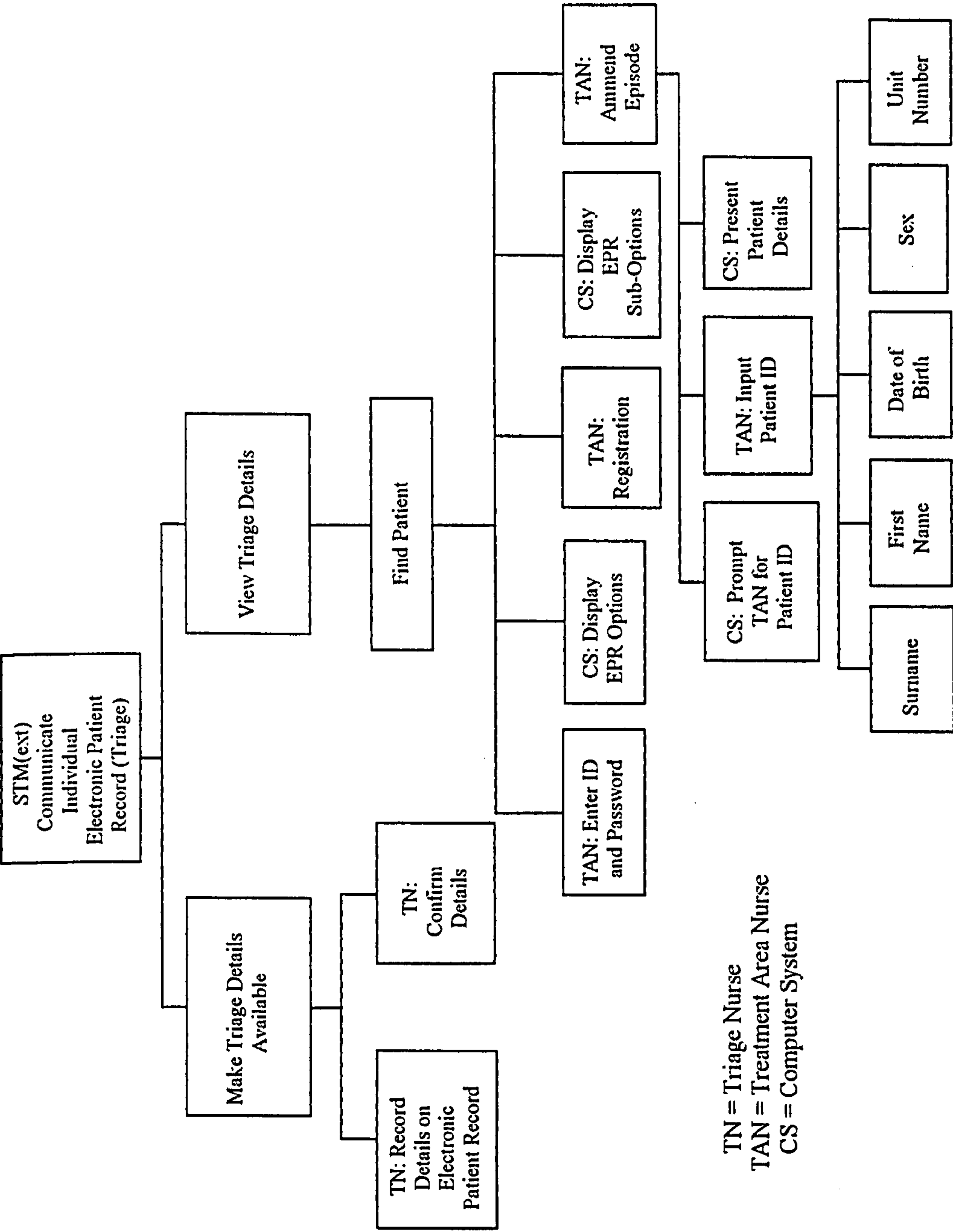


Figure 5.16: Extant System Task Model (STM(ext)) for A&E Worksystem (Communicate Individual Triage)



Name	Description	Design Speculation
Find Patient	Nurses frequently have to find the details of an individual patient in response to a telephone enquiry from a relative.	<p>The task of finding an individual patient record currently involves the computer system searching the complete A&amp;E database (the master patient index) which records all patients ever attending the A&amp;E department. Such searches are often complex and relatively time consuming</p> <p>In most cases, enquiries concern patients currently in the department, and occasionally those attending within the last 24 hours.</p> <p>Triage information for patients currently in the department could be found from more properly collated and presented triage information.</p> <p>The system should also support a more limited search for patients attending within the last 24 hours.</p> <p>A full search of the master patient index should be a last resort.</p> <p>Access procedures should minimise user actions which are currently over-complex (see STM diagram).</p>

Table 5.9: Extant System Task Model (STM(ext)) for A&E Worksystem (Communicate Individual Triage)

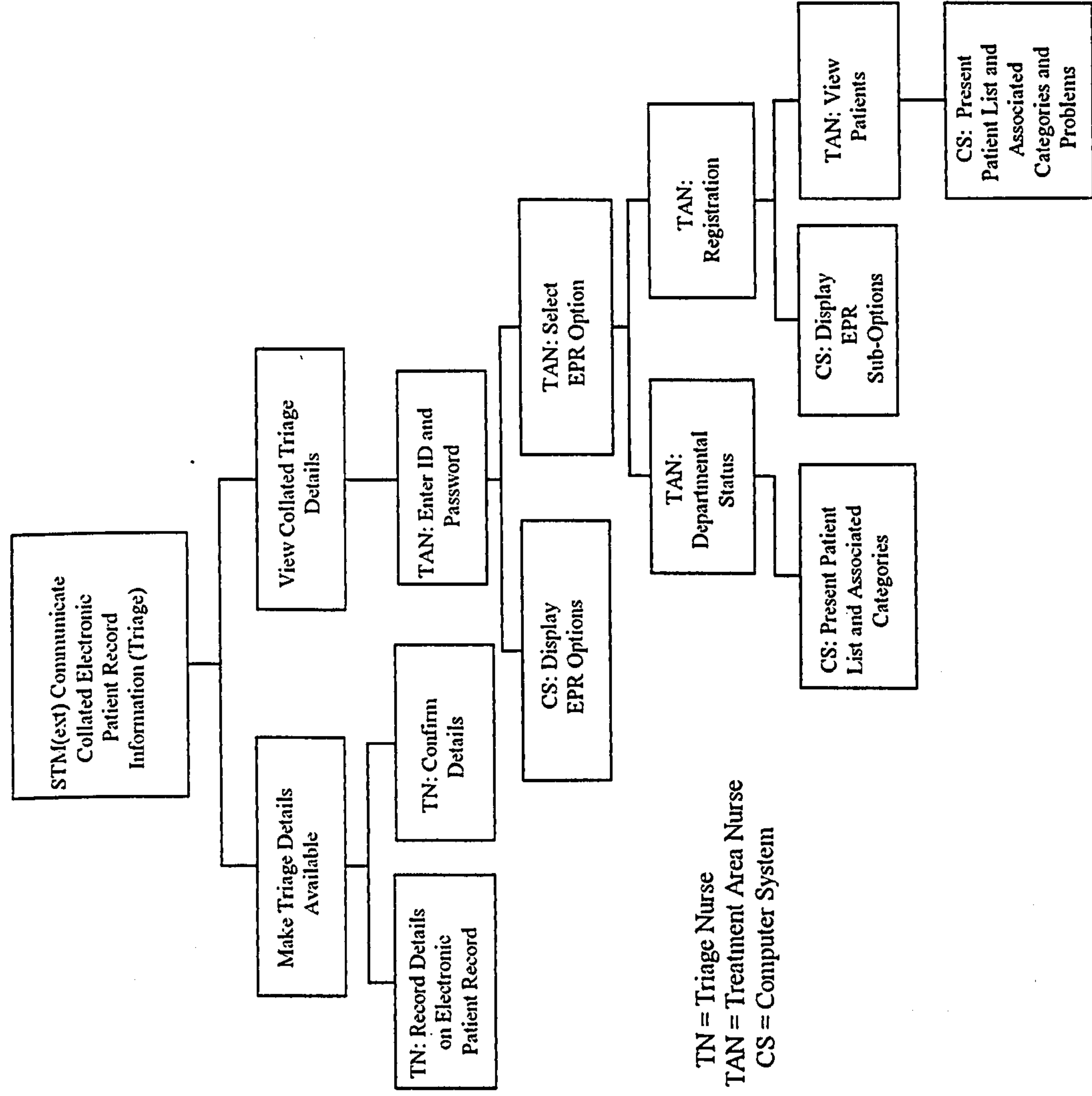


Figure 5.17: Extant System Task Model (STM(ext)) for A&E Worksystem (Communicate Collated Triage)



Name	Description	Design Speculation
CS: Present Patient List and Associated Categories	Neither of the two existing computer records presents a complete view of the collated triage data (where completeness would comprise: patient ID, category, priority and problem description). Priority, for example, is not presented for lists of patients at all (and can only be identified for individual patients).	Fully collated triage data should include a list of patients, their problems, their categories and their priorities. Current triage information is fragmented and, therefore, information that may be useful for forward-planning is not retrieved. Information that might support forward-planning (the number of priority 1 chest pains expected in majors, for instance) would allow medical staff to plan appropriate assessments for these types of patients (by checking ECG technician availability, for instance).
CS: Present Patient List and Associated Categories and Problems		The lack of properly collated triage information may explain why (as described in the Td(ext)) treatment area nurses do not use the triage information that is provided on the computer system. Indeed, access to the information that is provided is also somewhat convoluted, and nurses therefore use manual procedures (CAS cards) even though such procedures do not provide suitable summary information either.
		Fully collated triage data should also be provided 'at a glance' from a single screen. The presentation of such real-time information would reduce the mental costs associated with forward planning, and reduce physical costs insofar as nurses would make fewer visits to triage to monitor the numbers and patients waiting to come into the treatment areas. For selected machines, therefore, it may be important to present this information continually, since the situation is constantly changing.

Table 5.10: Extant System Task Model (STM(ext)) for A&E Worksystem (Communicate Collated Triage)

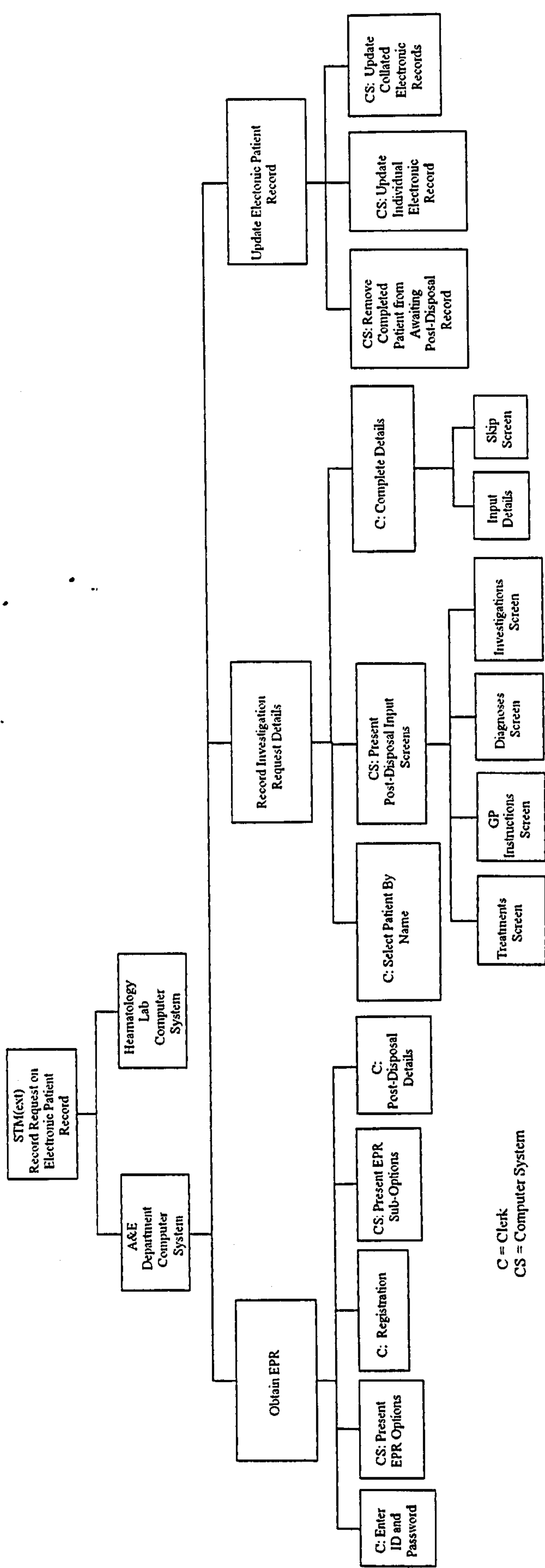


Figure 5.18: Extant System Task Model (STM(ext)) for A&E Worksystem (Record Investigation Request/Result)



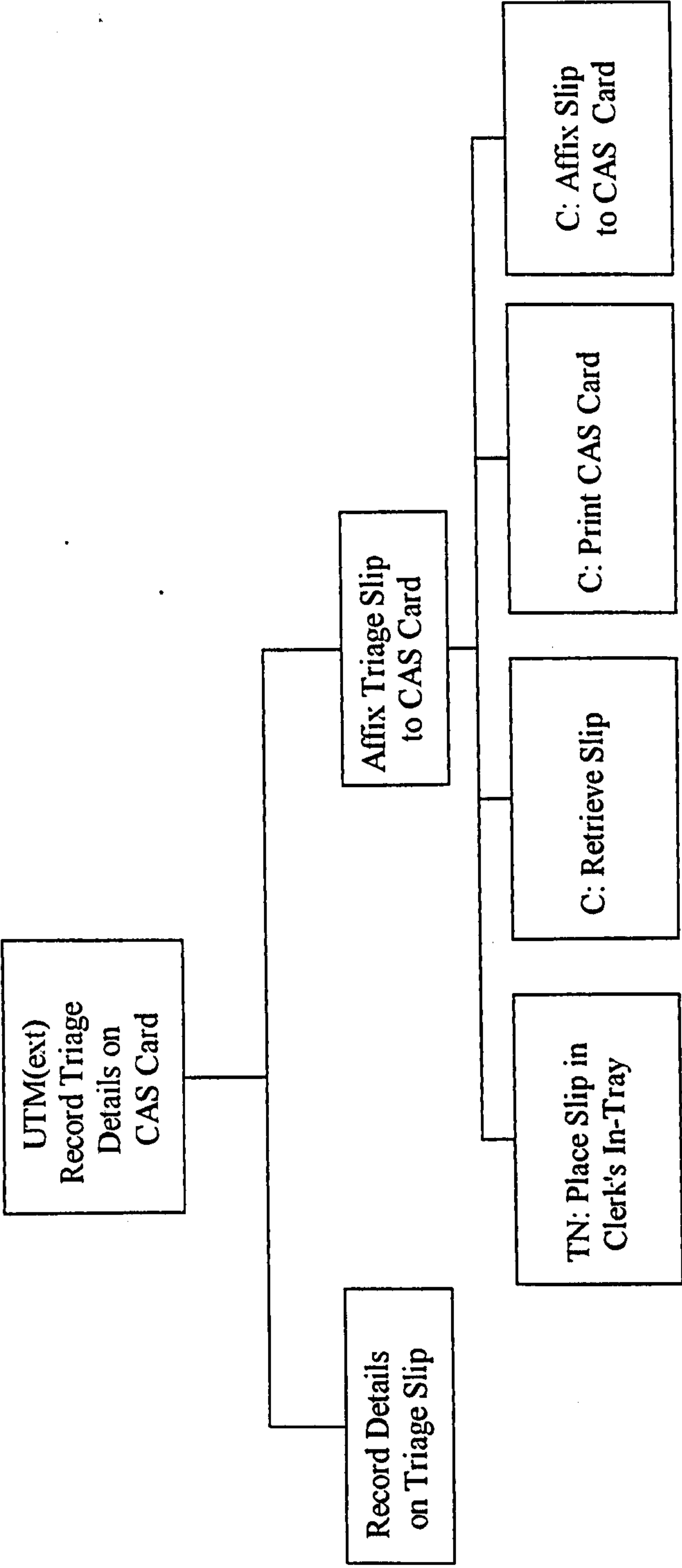
Name	Description	Design Speculation
CS: Present Post Disposal Input Screens	These screens support the recording of a standard set of A&E events when the patient has already left the department. Screens are presented in a pre-specified order. Investigations is the 4th screen.	
C: Complete Details	The post-disposals procedure often results in recording errors since the clerks are not necessarily medically trained, and may have difficulty reading and interpreting hand-written CAS cards.	<p>The post-disposals procedure is a result of the manual recording of investigation requests/results.</p> <p>In the case of investigation requests, if digital investigation requests were created, then the electronic patient record might be updated automatically when such digital requests are confirmed as correct and communicated to the labs.</p> <p>In the case of investigation results, the electronic patient record might be updated automatically with results directly from the lab analysis computer.</p>

Table 5.11: Extant System Task Model (STM(ext)) for A&E Worksystem (Record Investigation Request/Result)

### 4.3.3.Extant User Task Model (UTM(ext))

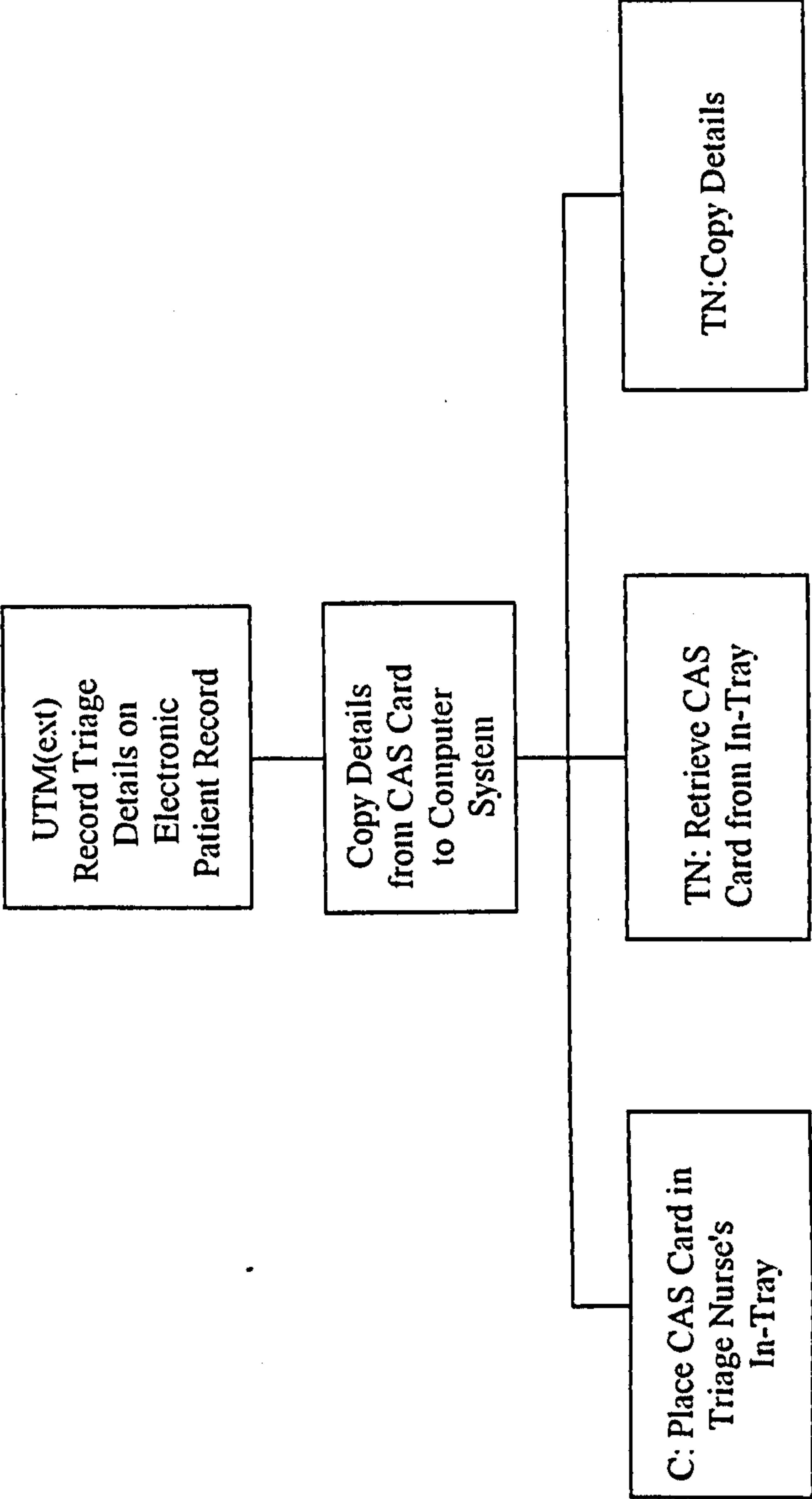
The UTM(ext) characterises the off-line task of the extant system. In particular, off-line tasks that may influence the user interface design of the extant and target systems should be represented explicitly. Again, the UTM (ext) is derived with reference to the GTM(ext), or with reference to the Td(ext), if a more detailed description is required. In this instance, the UTM(ext) was derived with respect to the Td(ext). The UTM(ext) is shown in Figures 5.19 - 5.23, and Tables 5.12 - 5.15.





TN = Triage Nurse  
C = Clerk

Figure 5.19: Extant User Task Model (UTM(ext)) for A&E Worksystem (Record Triage - CAS Card)



C = Clerk  
TN = Triage Nurse

Figure 5.20: Extant User Task Model (UTM(ext)) for A&E Worksystem (Record Triage - EPR)



Name	Description	Design Speculation
	<p>For convenience, and since they are substantially related, the following two triage recording tasks will be discussed together (despite the fact that they are taken from separate UTM(s)).</p> <p>In the case of recording the details on the CAS card, the triage nurse writes the details of the triage on a sticky label which is passed to the clerks in reception. The clerks then register the patient, print their CAS card, and attach the sticky label.</p> <p>In the case of recording the triage details on the EPR, the clerk passes the CAS card back to the triage nurse who then types the triage details into the computer system, using a separate triage screen.</p>	<p>Historically, patients were registered first on arrival in the department and were then triaged. Consequently, computer support was designed around this original system.</p> <p>The logic of the original design was as follows. Registration details were typed into the computer system by the clerks as they were elicited from patients. A list of registered patients was then displayed on a dedicated "triage lists" screen. Triage nurses would select a patient, and access a "triage details" screen where they could input their triage assessment during their interaction with the patient. Once these details were completed, the computer system automatically updated the electronic registration record to include the triage details. The triage nurse would then print this record, the result being the patient's CAS card.</p> <p>With the introduction of the Patient's Charter which stipulated that patients must be triaged within 5 minutes of arrival, this system began to fail (since registration might itself take longer than five minutes).</p> <p>The latest system version overcomes this problem, but means that triage nurses now have extra tasks to perform. They still have to input the triage information to the computer system, but they also have to hand write their assessment, and pass slips and CAS cards to-and-fro between themselves and the reception area.</p> <p>The system should reduce the time taken to input triage data to the EPR, and should obviate the need for triage nurses to create hand-written triage data.</p>
Record Triage Details on CAS Card		
Record Triage Details on Electronic Patient Record		

Table 5.12: Extant User Task Model (UTM(ext)) for A&E Worksystem (Record Triage)

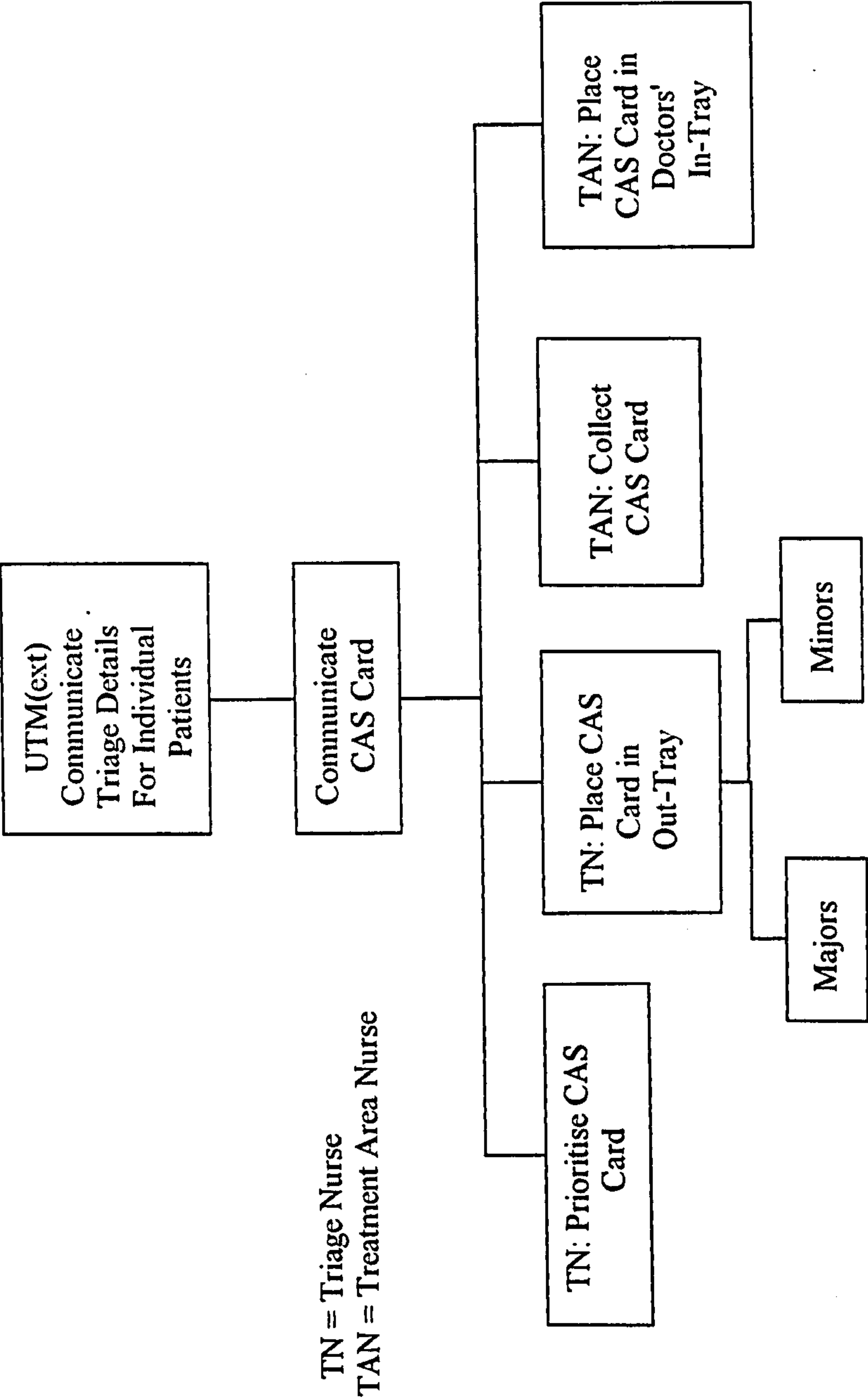


Figure 5.21: Extant User Task Model (UTM(ext)) for A&E Worksystem (Communicate Individual Triage)



Name	Description	Design Speculation
Prioritise CAS Card	Prioritisation is made on standard criteria (that is a priority 1 patient will be seen more quickly than a priority 2 patient) for each treatment area.	<p>Treatment area nurses do not currently know in advance the priorities (or types) of patients they will shortly receive. Forward-planning is thus precluded. An electronic version of the prioritisation would allow forward-planning which could reduce waiting times.</p> <p>Currently, the hard copy of the CAS card is printed by the clerks but is sorted by the triage nurses. In the context of an electronic version, it may be possible for printing of CAS cards to take place in the treatment areas (since this is the first point in the process where they are actually used {by doctors}).</p> <p>The triage area is small, and can become very crowded. It would reduce affective costs for all parties (and would improve performance times in triage) if the necessity for treatment area nurses to collect CAS cards was removed.</p>
Collect CAS Card	Treatment area nurses from majors and minors walk through to triage to collect CAS cards. This is typically done in relation to the number of treatment cubicles currently available or likely to become available in the near future.	

Table 5.13: Extant User Task Model (UTM(ext)) for A&E Worksystem (Communicate Individual Triage)

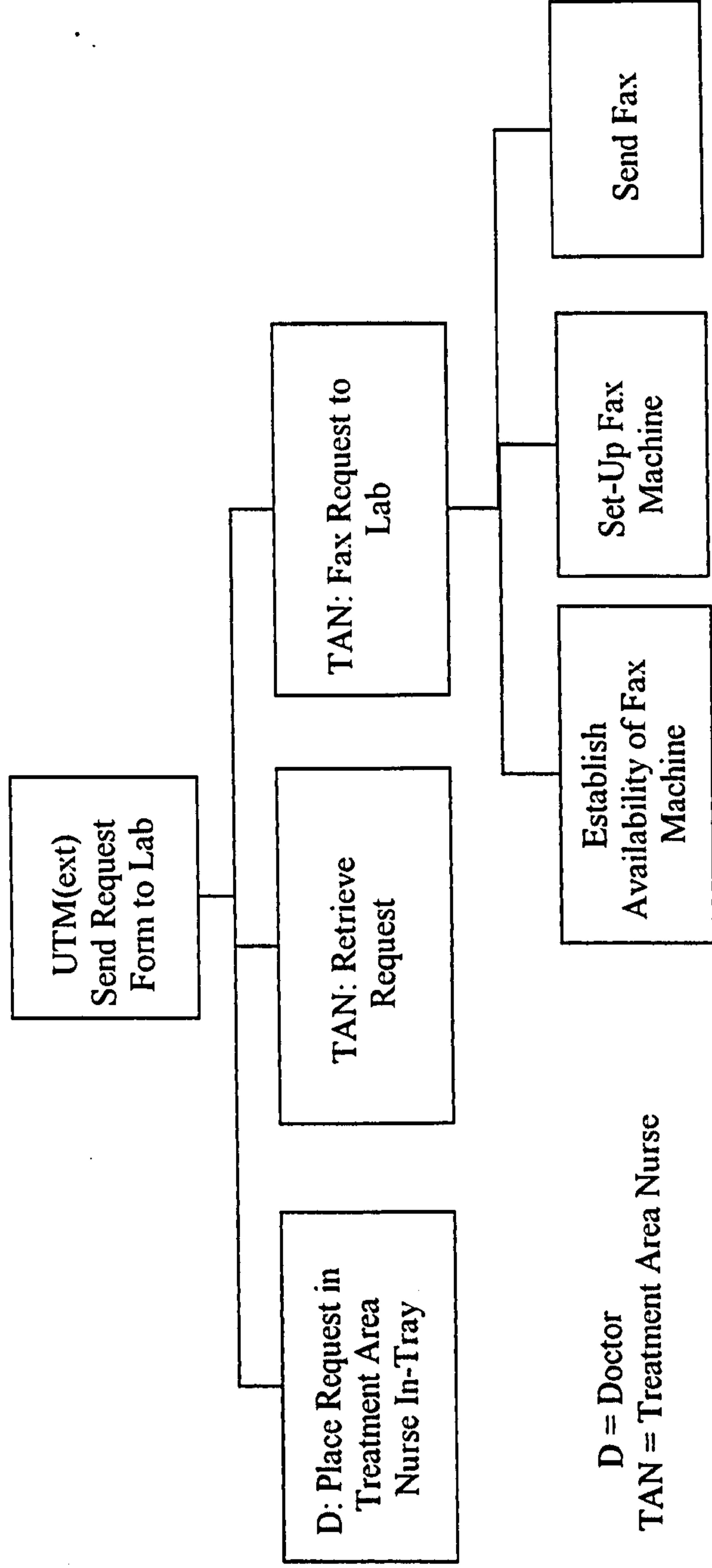
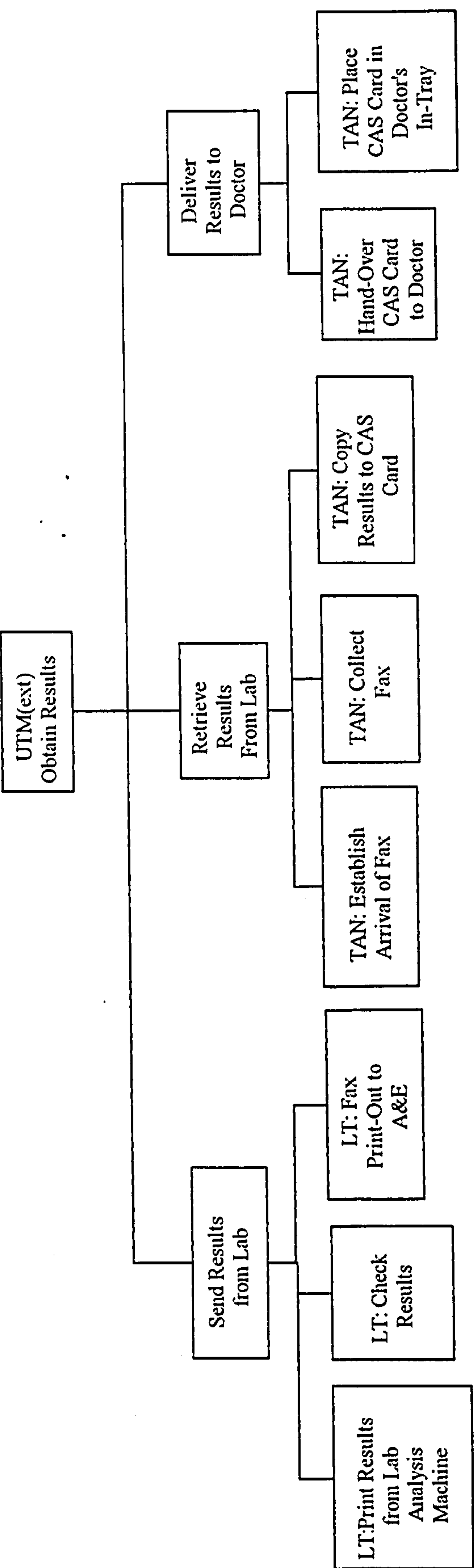


Figure 5.22: Extant User Task Model (UTM(ext)) for A&E Worksystem (Send Request)



Name	Description	Design Speculation
N: Fax Request to Lab	Nurses in the treatment areas send faxes (request forms) to the haematology labs from a single fax machine in majors.  Sending request forms to the labs involves a lot of movement around the department.	Consider the user of asynchronous communication (see below) to reduce movement around the department, to improve the timeliness and quality of requests.
N: Establish Availability of Fax Machine	The fax machine may often be busy (as may be the fax machine in the labs). This means that a considerable amount of time is lost, and considerable frustration occurs during busy periods, and also untimely investigations.	The computer system should, therefore, allow nurses to send digital request forms directly to the haematology lab.
N: Send Fax	Documents (particularly hand-written requests) may suffer decrement during faxing (becoming faint or illegible).	Digital requests would not suffer these types of decrement.

Table 5.14: Extant User Task Model (UTM(ext)) for A&E Worksystem (Send Request)



LT = Lab Technician  
TAN = Treatment Area Nurse

Figure 5.23: Extant User Task Model (UTM(ext)) for A&E Worksystem (Obtain Results)



Name	Description	Design Speculation
LT: Print Results from Analysis Machine	The analysis computer generates digital results which are subsequently printed-out by the technician. The print-out is checked, and then faxed to A&E.	These manual procedures are required because of incompatibility between the lab and the A&E systems. These systems should be integrated and networked to support the digital transfer of results. Results would have to be checked on-screen prior to sending.
LT: Check Results		
LT: Send Fax to A&E		
TAN: Establish Arrival of Fax	Nurses periodically check incoming faxes when they are awaiting results. Collection and periodic checking both interfere with their flow of work, and involve movement between treatment areas.	These manual procedures are time-consuming and ineffective. Digital transfer of results would obviate much unnecessary movement around the department.
TAN: Collect Fax		
TAN: Deliver Results to Doctor	The nurse copies the results to the patient's CAS card, and then either hands the card to the doctor or places it in the doctor's in-tray.	Doctors rely on nurses to provide them with results. Digital transfer might allow doctors to see the results of an analysis on-screen, though nurses might still be responsible for transferring the results to the CAS card in the normal manner.

Table 5.15: Extant User Task Model (UTM(ext)) for A&E Worksystem (Obtain Results)

## 4.4. Statement of User Needs (SUN) Stage

The Statement of User Needs Stage summarises the conclusions of the extant systems analysis, and defines requirements for the target system. In this study, we specify a Target Statement of User Needs (SUN(y)) to define the purpose of, and requirements for, the target A&E healthcare information system which is the focus of the redesign activities.

As described in Section 3.3, the SUN(y) in this particular instance, collates, re-describes, arbitrates between and synthesises information from: the Generalised Task Model of the Target System (GTM(y)); the clients statement of requirements; the Extant Task Description (Td(ext)); the Extant Generalised Task Model (GTM\*(ext)); the Extant Domain of Design Discourse Description (DoDD\*(ext)); the Extant System Task Model (STM\*(ext)); and the Extant User Task Model (UTM\*(ext)).

Lim and Long (1994) suggest that, as a rule, the Target Statement of User Needs comprises a textual description that should address the following:

- a) user requirements, general design constraints and performance criteria associated with the target system
- b) user problems with the existing system uncovered by human factors assessments at the ESA Stage
- c) human factors design recommendations and potential solutions to existing problems described in b) above
- d) promising features of extant designs and the rationale underlying their potential recruitment to the design of the target system

In Section 4.4.1, we will provide concrete examples of how these factors a), b) and c) can be incorporated in textual descriptions which (at least informally) map onto our current purpose (that is, to identify performance requirements through the identification of problems associated with existing system tasks).

The reasoning supporting the derivation of the SUN(Y) is summarised in the following section, and the SUN(y) itself is presented in Table 5.16.

### 4.4.1. Reasoning Supporting the Derivation of the SUN(y)

In the current study, the GTM(y) was used to organise the information from the Extant Systems Analysis Stage. Specifically, problems with the extant system were interpreted in the context of the target system, and the initial statement of requirements (as represented by the GTM(y)) was extended by recruiting descriptions from the products of the Extant Systems Analysis Stage. This information was summarised textually to derive the SUN(Y).

The GTM(y) identified three tasks which the target system should support: *Communicate Triage Information*; *Communicate Investigation Requests*; and *Communicate Investigation Results*. However, as the GTM(y) table suggests, the clients have focused on



communication, whilst ignoring how triage information, investigation requests, and investigation results are prepared and recorded prior to communication. For this reason, there are three additional tasks which the target system should support, these are: *Record Triage Information*; *Record Investigation Requests*; and *Record Investigation Results*. Together, these six tasks provide the context in which to interpret problems with the extant system, are considered in turn below.

#### 4.4.1.1. Target System Task 1: Record Triage Information

From Figure 5.11/Table 5.4 (the DoDD(ext)) and Figure 5.14/Table 5.7 (extant system performance), we can see that triage is the first point of contact between the patient and the A&E department. This first encounter is governed by official rules which specify that a patient must be triaged in less than five minutes. Triage time is monitored and recorded, and is an important statistical benchmark (from the hospital's perspective) of the performance of the A&E department. However, we can also see that triage information needs to be accurate (for the purpose of prioritising patients) and complete (for the purposes of the management of resources, and diagnosis).

Consideration of the Td(ext) table for triage, however, indicates that the recording of triage information involves the creation of both electronic and physical versions of patient data. The physical version is hand-written (as a component part of the patient's CAS card) and is used primarily in the treatment areas, so that doctors have quick reference to the current status of the patient, that can be easily updated and is portable. The electronic version is used by senior nurses in the treatment areas to organise available resources for patients. However, because of the poor computer representation of this data (see following section), this task fails to manage the resources most effectively. The electronic version of triage information is also used for hospital statistics. Because of the importance of the electronic version (despite its current ineffectiveness), the following requirement is proposed:

- i) The system should obviate the need for triage nurses to create hand-written triage information. That is, triage information should be recorded solely in electronic form.

However, due to the importance of the physical representation of triage information in supporting doctors in the diagnosis of patients, a further requirement is proposed:

- ii) Triage information pertaining to a patient episode must be made available in a physical representation once a patient is admitted to a treatment area.

However, although the requirement to create only an electronic version is likely to offer some improvements to the time taken to record a triage episode, further improvements should be ensured, leading to the following additional requirement:



iii) The system should minimise the time taken by triage nurses to input triage data to the electronic patient record (performance improvements may be assessed with respect to current input times).

The nurses also have a tendency to input inaccurate triage times, since the pressure on them to perform within specified time limits is intense. Inputting inaccurate triage times means that hospital statistics are meaningless, and it is recommended that:

iv) The system should automatically calculate and record triage times.

Furthermore, it was noted that triage nurses spend a considerable amount of time formulating (often idiosyncratic) descriptions of the patient's presenting problem. However, elsewhere in the hospital (e.g. during post-disposal) computer-based clinical thesauri are used to support the standardisation of clinical descriptions. It is likely that the use of such systems in triage could reduce triage times (and support more accurate diagnosis), leading to a further requirement:

v) The system should include computer-based clinical thesauri to support the rapid formulation of standardised problem descriptions by triage nurses.

#### *4.4.1.2. Target System Task 2: Communicate Triage Information*

First the DoDD(ext) was examined to identify: who uses triage information; for what purpose; and which aspects of triage information are important in each instance.

From Figure 5.13/Table 5.6 (Extant Information Flow), we can see that triage information is passed between the triage nurses and the clerks and back again, and then onto the treatment area nurses (supporting the prioritisation of patients and the management of resources) and the doctors (supporting diagnosis).

In particular, it was noted that the information provided to treatment area nurses was ineffective, insofar as the current representations of that information do not support the task of planning for the types of patients that are waiting for diagnosis and treatment (see Tables 5.0 - 5.3). It was noted in Table 5.0 that this ineffectiveness is due to the lack of properly collated and presented triage data, leading to the requirement for re-design:

vi) The system should provide continually up-dated collated triage information for all patients currently waiting for admittance to a treatment area in a single computer representation. Where collated triage data should comprise a patient list and complete triage records for each patient. It should be possible to specify this computer representation as the default representation for selected individual machines.

It was noted in Table 5.0 that, in most cases, provision of properly collated triage information would support general responses to enquiries from patient's relatives (since it



details the complaint and its seriousness, the time of arrival, and also indicates which treatment area the patient will attend - N.B. most replies are general in nature to protect the patient's interests). However, it was also noted that sometimes an enquiry does not concern a patient who is currently in the department, but who has attended fairly recently. For this reason a further requirement is proposed:

- vii) The system should provide a facility to find the triage details of patients attending the department in the last 48 hours. This facility should be easily accessed from all parts of the system.

#### *4.4.1.3. Target System Task 3: Record Investigation Requests*

Consideration of the Td(ext) for investigation requests indicates that during the specification of an investigation request, the doctor (in the treatment area) has to duplicate this request on a standard request form (in this case, an haematology request form) and also on the patient's CAS card. It is further noted, from Tables 5.1 and 5.2, that the clerks, responsible for post-disposal, copy the investigation request details from the CAS card onto the A&E electronic patient record and the lab technicians in the haematology department copy the details of the request onto the haematology lab computer system. For every investigation request, then, four copies of the same information are made for different purposes. This is clearly an inefficient process, and for this reason it is proposed that:

- viii) The system should support the creation (by doctors) of electronic investigation requests available to all parties as required.

In the case of post-disposal recording of investigation requests, the necessity for a clerk to type in the data may be obviated by the following requirement:

- ix) The post-disposals EPR should be updated automatically on the creation of electronic investigation requests (and should be automatically amended, if these are themselves amended).

However, clearly for these requirements to be met there is a need for a more general requirement:

- x) The A&E system and the pathology system should be compatible, and should be linked by an appropriate network.

#### *4.4.1.4. Target System Task 4: Communicate Investigation Requests*

To communicate investigation requests to the haematology lab, treatment area nurses currently fax the request form from a fax machine located in majors. Faxing requests in this way entails a lot of movement around the department, especially as the fax machine is often busy (as may be the fax machine in the labs), requiring either a wait or return visits for



further attempts. This process is clearly ineffective (in that investigation requests may be untimely), and inefficient (in that a considerable amount of time may be lost, and considerable frustration may result during busy periods. In general, then, the system might reduce the necessity for movement of staff between different parts of the department (e.g. between treatment areas), leading to the requirement:

- xi) The system should support the on-line asynchronous communication of electronic investigation requests to the haematology laboratory.

Additionally, investigation requests (particularly since they are hand-written) may suffer decrement during faxing (becoming faint or illegible). Asynchronous communication systems may bring their own legibility problems, and therefore:

- xii) The system should preserve the standard format of electronic investigation requests during asynchronous communication.

We can also see from the extant information flow (Figure 5.1.3), that doctors often consult more senior colleagues (e.g. consultants) for advice on the investigations they are proposing. The doctor may be able to meet with the consultant face-to-face, but more often uses the internal telephone system to discuss the investigations specification. However, investigation specifications may be complex, and particularly in the case of telephone communication, the medium in which the specification is presented (i.e. speech) may result in ineffective assessments (because of misunderstandings or interpretation errors). Such ineffectiveness may be obviated by synchronous (real-time) text communication; for example:

- xiii) The system should support synchronous shared access (throughout the hospital) to electronic investigation requests.

#### *4.4.1.5. Target System Task 5: Record Investigation Results.*

Consideration of theTd(ext) for investigation results indicates that recording of investigation results involves considerable duplication. First, the result must be created by the haematology lab analysis machine and a suitable record created. This record is then printed-out and sent to the fax machine in majors were it is retrieved by the appropriate treatment area nurse and copied to the appropriate patient's CAS card. Finally, the investigation result must be copied from the CAS card to the patient's electronic record by the post-disposal clerk. The whole process, then, involves considerable redundancy and duplication, and leads to the requirement that:

- xiv) The system should support the creation (by lab technicians) of electronic investigation results made available to all parties as required.



In the case of post-disposal recording of investigation results, the necessity for a clerk to type in the data may be obviated by the following requirement:

- xv) The post-disposals EPR should be updated automatically on the creation of electronic investigation results (and should be automatically amended, if these are themselves amended).

Again, for these requirements to be met there is a need for a more general requirement:

- xvi) The A&E system and the pathology system should be compatible, and should be linked by an appropriate network.

#### 4.4.1.6. *Target System Task 6: Communicate Investigation Results.*

To communicate investigation results to the treatment areas, haematology lab technicians currently print out the results of the analysis, and fax the print-out to the fax machine located in majors. In majors, the faxes are retrieved by nurses and taken to the appropriate treatment area. Retrieving faxes in this way is clearly ineffective (in that investigation results may be untimely), and inefficient (in that a considerable amount of time may be lost, and considerable frustration may result during busy periods, leading to a particular requirement that:

- xvii) The system should support the on-line asynchronous communication of electronic investigation results from the haematology labs to the appropriate treatment areas.

Again, retrieving investigation results entails a lot of movement around the department by treatment area nurses which would be obviated by electronic asynchronous communication.

We can also see from the extant information flow (Figure 5.13/Table 5.6 ), that doctors often consult more senior colleagues (e.g. consultants) for advice on the results of investigations. The doctor may be able to meet with the consultant face-to-face, but more often uses the internal telephone system to discuss the investigations specification. However, investigation results may be detailed and complex, and particularly in the case of telephone communication, the medium in which the specification is presented (i.e. speech) may result in ineffective assessments (because of misunderstandings or interpretation errors). Such ineffectiveness may be obviated by synchronous (i.e. real time) communication, for example:

- xviii) The system should allow synchronous shared access (throughout the hospital) to electronic investigation results.

For convenience, Table 5.16 removes any redundancy, concatenates requirements where appropriate, and formulates a final set of requirements to be represented in the SUN.

**Target System Task 1: Record Triage Information**

1. The system should obviate the need for triage nurses to create hand-written triage information. That is, triage information should be prepared solely in electronic form.
2. Triage information pertaining to a patient episode must be made available in a physical representation once a patient is admitted to a treatment area.
3. The system should minimise the time taken to input triage data to the electronic patient record (performance improvements may be assessed with respect to current input times).
4. The system should automatically calculate and record triage times.
5. The system should include computer-based clinical thesauri to support the rapid formulation of standardised problem descriptions by triage nurses.

**Target System Task 2: Communicate Triage Information**

6. The system should provide continually up-dated collated triage information for all patients currently waiting for admittance to a treatment area in a single computer representation. Where collated triage data should comprise a patient list and complete triage records for each patient. It should be possible to specify this computer representation as the default representation for selected individual machines.
7. The system should provide a facility to find the triage details of patients attending the department in the last 48 hours. This facility should be easily accessed from all parts of the system.

**Target System Tasks 3 & 5: Record Investigation Requests/Results**

8. The system should support the creation (by doctors) of electronic investigation requests, available to all parties as required.
9. The system should support the creation (by lab technicians) of electronic investigation results, available to all parties as required.
10. The post-disposals EPR should be updated automatically on the creation of electronic investigation requests/results (and should be automatically amended if these are themselves amended).
11. The A&E system and the pathology system should be compatible, and should be linked by an appropriate network.

**Target System Task 4 & 6: Communicate Investigation Requests/Results**

12. The system should support the on-line asynchronous communication of electronic investigation requests/ results between the treatment areas and the haematology labs.
13. The system should preserve the standard format of electronic investigation requests/results during asynchronous communication.
14. The system should allow synchronous shared access (throughout the hospital) to electronic investigation requests/results.

Table 5.16: Summary of User Needs Constructed by the Application of MUSE

## Summary

This chapter has constructed requirements for the re-design of an A&E healthcare information system through the application of the MUSE method which represents the postpositivist paradigm and the discipline of human factors (see Chapter 3). With respect to the characterisation of RE proposed in Chapter 1, MUSE has been used to: construct an *understanding* of the requirements problem via the construction of task descriptions and



task models of both the existing and the target A&E healthcare information system; and to construct a *specification* of the requirements for a software product via the construction of task descriptions and task models which support the conceptual design of the target A&E healthcare information system (in the form of a Statement of User Needs which outlines the purpose and performance requirements of the target system).

The next chapter describes the construction of requirements for the re-design of an A&E healthcare information system from the position of a different paradigm and discipline (the constructivist paradigm and the discipline of sociology).

## Chapter Six

# Requirements for an Accident and Emergency Healthcare Information System - Part 2: Application of Grounded Theory Method

Don't understand me too quickly.

Norman Mailer (1959)

### 1. Introduction

This chapter constructs requirements for the re-design of an A&E healthcare information system through the application of a method which represents the constructivist paradigm and the discipline of sociology (see Chapter 3). The method to be used here is the Grounded Theory method (Glaser and Strauss, 1967; Glaser, 1978; Strauss and Corbin, 1990).

With respect to the characterisation of RE proposed in Chapter 1, the Grounded Theory method is used here to: construct an *understanding* of the requirements problem via the construction of a rich description of the organisational and social culture of the A&E department and its work practices; and to construct a *specification* of the requirements for a software product via the construction of analytic categories that can be used to develop an understanding of potential requirements for an healthcare information system. The Grounded Theory method *represents* the outputs of each of these processes using qualitative, detailed, natural language descriptions.<sup>28</sup>

Section 2 outlines the Grounded Theory method, and illustrates the way in which the method is used to construct a grounded theory (using examples from the analysis of the A&E data). Section 3 presents the output of the method's application to the A&E data, and shows how it constructs interactive system requirements in the form of an analytic report<sup>29</sup> that offers support for the re-design of an healthcare information system. The chapter concludes in Section 4 with consideration of the benefits and limitations of the analysis.

### 2. Grounded Theory Method of Analysis

The Grounded Theory method of analysis was first proposed as a method to develop theoretical accounts and explanations which conform closely to the specific situations or

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<sup>28</sup> Using the Grounded Theory method to support the process of requirements *validation* is not addressed here.

<sup>29</sup> For reasons outlined in Section 5, we prefer to think of this analytic report as a particular conceptualisation of the situation in the A&E department studied rather than a theory *per se*.



phenomena under consideration (Glaser and Strauss, 1967). A grounded theory, then, is one that is inductively derived from the study of the phenomenon it represents (in contrast to theory generated by logical deduction from *a priori* assumptions), and is hence firmly *grounded* in the data on which it is based. In this way, a grounded theory is faithful to the everyday realities of the area under study, and is claimed to be highly applicable to dealing with them (Strauss and Corbin, 1994). Martin and Turner (1986) suggest that a grounded theory primarily justifies itself by providing a detailed account of the area under investigation that can be used to: aid the investigator's understanding; aid communication with those studied and other the researchers practising in the area; and act as a vehicle for guiding and implementing change in the area of concern.

The Grounded Theory method is primarily used in field studies involving either participant observation or unstructured interviewing (Pidgeon et al, 1991), and uses explicit coding and analytic procedures to systematically examine and categorise (mainly qualitative) empirical data. The method comprises three analytic procedures that represent the operations by which the data are broken down, conceptualised, and re-organised. These three procedures are: *open coding* (during which the analyst breaks down the data looking for leads, ideas and issues in the data themselves); *axial coding* (during which the analyst reorganises the data around selected conceptual categories representing recurring themes, and builds dense conceptual linkages around the 'axis' of the category being focused upon); and *selective coding* (during which the analyst selects a single *core* category which is considered to be central to the research, and systematically links all other categories to this core). The use of these three procedures is a non-linear and iterative process (Glaser, 1978; Turner, 1981), and the analyst typically alternates between the three procedures as the analysis proceeds (Martin and Turner, 1986).

The three coding procedures are supported by the writing of memos which are analytic elaborations of ideas about the data and the coded categories. By writing memos systematically while coding, the researcher fills out and builds the categories and develops the depth and scope of the analysis leading ultimately to the creation of a final theoretical monograph, report, paper or the like (Charmaz, 1983). Strauss (1987) recommends that one should frequently interrupt coding in order to write memos. Memos can be as short as a sentence or many pages long, and are used to record and elaborate on ideas generated during coding (Glaser, 1978). In essence, memos are used as sense-making tools that tie together ideas about the data (Miles and Huberman, 1984).

More specifically, memos are used to support the analyst in keeping track of all the categories, properties, hypotheses, questions and so on that evolve from the analytic process. Memos help the analyst move from empirical data to a conceptual level, refining and expanding codes further, developing key categories and showing their relationships, and



building towards a more integrated understanding of the analysis. Memos are about ideas and insights, and as such contain the products of the analysis.

Memos vary in form according to the stage of the analysis, and the type of coding one is performing. There are, however, three basic types: *code notes*; *theoretical notes*; and *operational notes*, which contain, respectively: the products of the actual coding; theoretically sensitising and summarising notes; and directions for sampling (see the individual sections below for details). Memos accumulate over the course of the analysis, enabling the analyst to keep an ongoing record of the analytic process, and are sorted and grouped as a start-point to writing-up the analysis.

Sections 2.2 to 2.4 provide more detailed summaries of the three coding procedures and their supporting memos, and illustrate each of the components of the method with exhibits from the actual analysis of the A&E department used as a case study in this thesis. Section 3 presents a detailed report which was the outcome of the method's application.

First, however, we will provide a glossary of important terms which are used throughout the chapter.

## 2.1. Glossary of Terms

This section presents a glossary of terms used in the Grounded Theory method. Terms which are cross-referenced are underlined in the text.

**Axial Coding:** A set of procedures to make connections between categories.

**Category:** A classification of concepts. This classification is discovered when concepts are compared against one another and appear to pertain to a similar phenomenon. Thus, the concepts are grouped together under a higher order, more abstract concept called a category.

**Code Notes:** Memos containing the actual products of coding: concepts; and the properties and dimensions of categories.

**Coding:** The process of analysing data. There are three types of coding process: open, axial and selective.

**Concepts:** Conceptual labels placed on discrete incidents, events, and other instances of phenomena.

**Core Category:** The central phenomenon around which all other categories are integrated.

**Data:** Typically, field notes, interview transcripts, or documents (i.e. language in the form of text).

**Data collection:** The finding and gathering - or generating - of data for analysis.

**Dimensions:** Location of properties along a continuum.

**Memos:** The write-up, and conceptual elaboration, of the analysis. There are three basic types of memo: code notes; theoretical notes; and operational notes.



**Open coding:** The process of breaking down, examining, comparing, conceptualising and categorising data.

**Operational Notes:** Memos that indicate directions for future data collection, and analysis.

**Phenomenon:** The central idea or category identified by the analysis.

**Properties:** Attributes or characteristics pertaining to a category.

**Selective Coding:** The process of selecting the core category, and systematically relating it to other categories.

**Theoretical Notes:** Theoretically oriented memos.

Having provided a glossary of terms that will be used throughout this chapter, the following sections describe in detail the constituent parts of the Grounded Theory method. Sections 2.2 to 2.4 provide more detailed summaries of the three coding procedures and their supporting memos, and illustrate each of the components of the method with exhibits from the actual analysis of the A&E department used as a case study in this thesis.

## 2.2. Open Coding

Open coding is concerned with the conceptual labelling and categorising of phenomena through detailed examination of the data. During open coding, data are broken down into discrete parts and compared for similarities and differences (Strauss and Corbin, 1990).

Open coding comprises four activities: labelling phenomena; discovering categories; naming categories; and developing categories in terms of their properties and dimensions.

As indicated in the introduction to this section, open coding is supported by the use of memo writing. *Code notes* take the form of conceptual labels, categories, properties and dimensions. Incidents can be described in terms of their specific properties and their location along a dimensional continuum. The conditions that gave rise to those particular properties are useful in establishing why properties take up a particular dimensional position. Conditional relationships may be written as hypotheses. *Theoretical notes* pick up where code notes leave off. That is, they can extend the analysis of a concept by: asking exploratory questions; making use of relevant literature; analysing other sources of research in the area and so on. *Operational notes* give directions for sampling, things to look for and questions to ask in the next round of data collection or analysis.

Each of the four activities of open coding, and the memos associated with coding of this type, are considered below.

### 2.2.1. Labelling Phenomena

The first task for the analyst is to break down and conceptualise the data that has been collected. The data is scrutinised (line-by-line, or word-by-word) to identify discrete



incidents (e.g. actions, events, happenings, ideas, issues, etc.). These incidents are taken as potential indicators of phenomena, which are thereby given conceptual labels (or codes). During the analysis, incidents are constantly compared to ensure that similar phenomena are given the same name.

Typically, the analyst will ask questions of the data as the coding proceeds. The most general questions are often: "what category does this incident indicate?" and "what is actually happening in the data?" Asking questions of this type helps the analyst identify the key elements of the data and generate codes with strong relationships to other codes.

Exhibit 1 is an illustration of the line-by-line analysis of an interview transcript prepared by the author. First we present the first four paragraphs of the interview (which actually extended to thirty-five double spaced typed pages), then we illustrate how those four paragraphs were analysed.

#### **Exhibit 1: Segment of Interview with Charge Nurse (R1)**

Source notes: Interview taken at end of night shift (between 7am - 8.30am), Tuesday July 11th 1995. Respondent (who was responsible for organisation of the night shift) stayed on for an hour of his own time to complete the interview, and give me a guided tour of the whole department.

1. "You see, the ambulance patients come in this side, and walking wounded come in here. Now, we offer a system of triage with the nurses before they actually book in, especially with walking-wounded. They actually, instead of going up to reception window, first of all they come up to the triage desk here. The triage nurse writes brief details of what they've come in with. Their name, time that they're actually triaged. Just a brief history of what they've come in with, problem. Then they go to the window and book in.

2. Depending on what they've come in with... Obviously, anyone whose complaining of things like severe chest pain, abdominal pain, anyone who looks ill, who needs really to be seen either immediately, or within half-an-hour because their condition is deteriorating, instead of booking in is brought in to the triage area, put on a trolley, if they're not already on a trolley, and either moved into resuss to be seen straight away. You know, anyone maybe who's had a heart attack, or has got an acute appendix, may deteriorate within half-an-hour. We either bring them straight in, or start doing investigations like just taking bloods or doing the heart recording. If we still consider that the patient needs to be seen within half-an-hour, we'll let the sister in charge know, so that she can make beds available.

3. See, part of the triage nurse's job is to, if there's enough on, to do bloods and to do heart recording, because everyone who comes in with chest pains is supposed to have that within five minutes and be reported on. We still get a lot of chest pains coming in. It may not be heart, it might not be anything life threatening, but we still have to do the ECG. Doesn't always work in very busy periods.

4. If they've got relatives, then fair enough they can give their details. If there's no relatives, we have to get the receptionist to come out of reception, either go with the patient or wait in here till the room comes up to get the details so the card can be printed. Walking-wounded just go to the window and book in."

The analysis of these four paragraphs ran as follows. First, each line was carefully examined and annotated (shown here by the presentation of the analyst's comments and



questions in brackets). Underneath each paragraph a set of conceptual labels (codes) suggested by that paragraph is provided.

1. "You see, the ambulance patients (a type or category of patient. What other categories are there? For instance, we later see that another type is 'walking-wounded.' Does the type of patient effect how they are handled as they come into the department?) come in this side (this indicates that there is a differentiation of physical space that influences the way that patients arrive in the department. How exactly does this physical differentiation affect how the patients are perceived and managed? Does it affect their initial assessment?), and walking wounded (another type of patient) come in here (again a differentiation of physical space). Now (does this indicate that this was not always the way things were done?), we offer a system (this is an interesting term. Does this system have rules? What are its components and procedures? ) of triage with the nurses (and no doctors, presumably? What type of nurse does triage? Do they play other roles in the department? How many of them are there? What skills and experience do they need?) before they actually book in (is this a formal/official event. What does it involve? What is its purpose?) especially with walking wounded (this seems to indicate that it is different, if the patient is an ambulance patient). They actually, instead of going up to reception window (this is the old system, I presume, check this out), first of all (this implies a procedure of how patients are processed in stages), they come up to the triage desk here (the patients bring themselves to the desk). The triage nurse writes (what does he or she write this on? What happens to what is written? What status does this have in the patients case notes?) brief details (why brief?) of what they've come in with (is this what the patient says their trouble is? Or what the nurses say it is? How do the nurse and the patient co-operate in establishing this?). Their name, time that they're actually triaged (this must be important for records, check this). Just a brief history of what they've come in with, problem (how does a problem relate to a diagnosis?). Then they go to the window and book in (notice the window is glass screened. What effect does this have on this interaction? Why is the reception window screened, but not the triage desk?).

#### Codes suggested by Paragraph 1

- Categorising patients by type
- Physical space and its influences
- Assessment
- Administration
- Information collection and recording
- Patient movement

2. Depending on what they've come in with... (this implies conditions which influence what happens to the patient next). Obviously, anyone whose complaining of things like severe chest pain, abdominal pain (categories of serious illness? What other indicators are there? Is this laid down in procedures?), anyone who looks ill (is this an informal judgement on the part of the nurse? What do they look for?), who needs (could this be a dimension of the patient?) really to be seen (by a doctor, I presume) either immediately, or within half-an-hour (these sound like formal rules about how long certain illnesses can wait) because their condition is deteriorating (another condition of a serious illness), instead of booking in (i.e. because they are very ill they don't worry about the paperwork) is brought in to the triage area (behind the triage desk), put on a trolley (is this for the comfort of the patient? Or to make it easier to move them around?) if they're not already on a trolley (so they can be on trolleys already, from the ambulance I assume. Obviously, not all ambulance patients are brought in on trolleys. How else are they brought in - on stretchers, on foot, in wheelchairs?), and either moved (a transport function? Who does the moving?) into resuss to be seen straight away (do you have to be allocated to resuss to be seen straight away? Check this). You know, anyone maybe who's had a heart attack, or has got an acute appendix (more



categories of illness and its seriousness. I need to check what falls into these categories), may deteriorate within half-an-hour. We either bring them straight in (this implies a short-cut into the A&E process. i.e. they don't have to wait), or start doing investigations like just taking bloods or doing the heart recording (this seems to be done on the triage nurses own initiative. Implies that they have authority for certain tasks). If we still consider (a judgement. Does this carry responsibilities with it? Are triage nurses responsible for mistakes? Is there a doctor to back them up on decisions such as this?) that the patient needs to be seen within half-an-hour we'll let the sister in charge know (co-operation between staff. Authority and hierarchy. There must be lots in the literature on hierarchies in hospitals) so that she can make beds available (how does she do this? Does this imply some pre-planning? How much notice does she need? What are the implications for other patients?).

#### Codes suggested by Paragraph 2

- Categorising illness by severity
- Prioritising patients according to their categories
- Patient movement
- Rules, regulations and responsibilities
- Pre-planning to make resources available

3. See, part of the triage nurse's job (get a formal description of this, and an informal one too) is to, if there's enough on (this means staff, I assume. Are there times when there aren't enough staff?), to do bloods (needs syringes. Where are these kept? Link to supplies?) and to do heart recording (which requires equipment. Where is this kept? Is it portable? What happens to the results of both the ECG and the bloods? Who are they for? Do the nurses need qualifications to use them? Are they qualified to interpret them?), because everyone who comes in with chest pains is supposed to have that within five minutes (this implies some rules that have to be followed. Who monitors this? How often are these rules broken, and what are the consequences of them being broken?) and be reported on (is this a written report? What does it contain? Who is it for? For what purpose?). We still get a lot of chest pains coming in (why is this?). It may not be heart, it might not be anything life threatening (what are the types of illness that exhibit chest pains but are not life-threatening? Life-threatening may be a category. Is pain always an indicator of these types of illness?), but we still have to do the ECG (rules again). Doesn't always work in very busy periods (so the rules may be broken during busy periods. What are the consequences of this? How do the nurses make this decision? Look for other examples of rule breaking).

#### Codes suggested by Paragraph 3

- Staff limitations and their effects on the job
- Investigations
- Equipment use and provision
- Categories of illness
- Rules, regulations and responsibilities
- Degrees of demand (business) and their effects on the job

4. If they've got relatives (does this help categorise patients? What effect does having relatives around have on the department and how patients are treated?), then fair enough they can give their details (so relatives can accept responsibility for giving details about a patient? Is the status of the relative checked? Are the details checked? What are the characteristics of nurse-relative co-operation?). If there's no relatives, we have to get the receptionist to come out of reception (co-operation between staff as a category? What are the roles of the receptionists? Do they have medical training of any sort?), and they'll either go with the patient (go where?) or wait in here till the room comes up (that is a room becomes available, I presume?), to get the details so the card (the patient's casualty card) can be printed (who



does this?). Walking-wounded just go to the window and book in (there is a distinction here, then, between those patients who need to be escorted and those that don't. On what other occasions do the patients have responsibility for their own movement about the department. What are the consequences of this?)”

#### Codes suggested by Paragraph 4

- Interactions between staff, patients, and relatives
- Patient movement
- Staff movement
- Rules, regulations and responsibilities
- Categories of illness
- Assessment
- Administration

As we have seen from the line-by-line analysis illustrated above, a considerable number of questions about the data can be asked. These questions point to data that needs to be collected in the future, and what sort of information to look for (these may be developed into more explicit operational notes). More importantly, however, these questions allow the analyst to explore the data, and help stimulate thinking about potential concepts or categories and their properties (which is the subject of the next section).

### 2.2.2. Discovering and Naming Categories

Concepts that pertain to the same phenomena are now grouped into categories. They are generated through the same analytic process of making comparisons to highlight similarities and differences that is used to produce lower level concepts, and typically encompass several incidents or indicators found in the data. These groupings (and any proposed relationships they imply) are provisional at this stage, and are open to change under the influence of later coding sessions. Categories have conceptual power, because they are able to pull together around them other groups of concepts or sub-categories.

The phenomenon represented by a category is given a conceptual name. This name must be a more abstract concept than those it represents. These conceptual names may be: derived from the language of the data (essentially the terms used by the subjects themselves); disciplinary (that is, based on the analysts scholarly knowledge and knowledge of the substantive field being analysed); or novel (that is, new insights and constructions made by the analyst).

Constant iteration around the data and the codes used will often lead to changes in the names of codes, categories and their dimensions. Turner (1981) suggests that code and category labels may be long-winded or ungainly at first, but that this is unimportant, providing that the label has a good fit (that is semantically accurate) with the phenomenon described in the data. Table 6.1 shows the categories that were extracted, selected and named from the four paragraphs analysed above.

- Distinguishing between types of patient and their illness
- Cues and indicators supporting the prioritisation of patients
- Relationship between patient priority and actions
- Relationship between demand, resources and actions
- Rules and regulations
- Relationship between medical and administrative tasks
- Information collection, storage and retrieval
- Interactions between staff and patients
- Interactions between staff
- Patient movement

Table 6.1: Categories Generated from Analysis of Four Paragraphs of Interview Transcript

These categories can be further detailed by creating *category cards* which elaborate on the category (see Turner, 1981; Pidgeon et al, 1991; Miles and Huberman, 1994), and may be thought of as a further type of *code note*. These category cards are gradually elaborated further by the addition of concepts and data identified in subsequent interviews. Data analysis software can be used to support this activity (e.g. NUDIST, Richards and Richards, 1991) but the analysis for this study was conducted using only word-processing software (with indexing, outlining, annotation and search and replace facilities). As Pidgeon et al (1991) put it: the aim is to collect on each card a set of indicators pointing to the multiple facets of a potentially significant concept.

An example of such a category card for the category of *patient movement* is given in Figure 6.1 below.

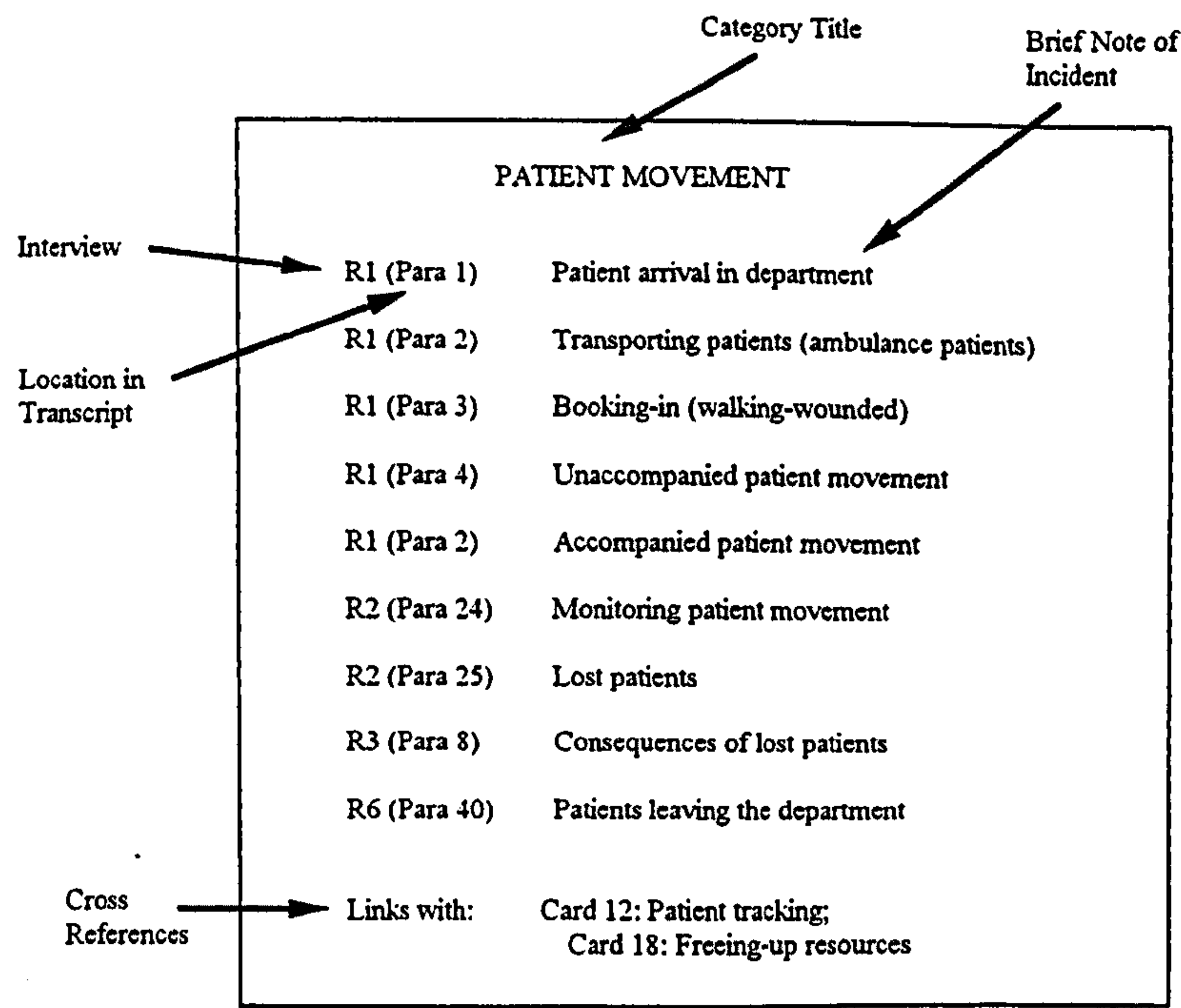


Figure 6.1: Example Category Card



Figure 6.1 shows how the category card groups incidents which are judged to pertain to the same phenomena, and indicates where in the data these concepts can be found. Cross-references to other categories are also identified, and these help the analyst look for category groupings which ultimately can give conceptual density to the emerging theory. Assembling and sorting category cards in this way also provides the analyst with a way to identify relevant categories, since some cards will have few entries and will typically become excluded from subsequent analysis.

As we can see from the category card shown in Figure 6.1, a range of incidents can be subsumed under a single heading, and indicate the multiple facets of the phenomena. Sometimes, however, the process of itemising incidents will indicate to the analyst the need to further refine a category. In the case illustrated above, it soon becomes clear that *patient movement* can be further sub-divided into *accompanied patient movement* and *unaccompanied patient movement*. Indeed, this distinction was already hinted at in the questions raised in the analysis of paragraph four, but has now been confirmed with further data. With our refined categories we can now return to the data, and re-code it looking for new refinements and dimensions.

### 2.2.3. Developing Categories in Terms of their Properties and Dimensions

Merely grouping concepts under a more abstract heading, however, does not tell us everything we need to know about that category, and the category must be developed in terms of the properties and dimensions of the phenomenon it represents. Where: properties are the characteristics or attributes of a category (phenomenon); and dimensions represent locations of a property along a continuum.

Properties and dimensions form the basis for making relationships between categories and sub-categories (and later between major categories).

Developing properties and dimensions is typically done through the use of memos which explore the category in more detail. Figure 6.2 shows a sample memo of this sort.

**MEMO: CODE NOTE: Properties and dimensions of unaccompanied patient movement on instruction by staff**

**DATE: 28/7/95**

**NOTES: Created During Open coding of Interview R1**

**MEMO LINKS: Memo: Who has responsibility for unaccompanied patients?**

**CARD LINKS: Card 12: Patient tracking**

Patients are often responsible for their movement around the A&E department. There are two types of unaccompanied movement:

- i) movement under their own initiative (e.g. arriving in the department or leaving it before the episode is completed)
- ii) movement on instruction by staff (e.g. asked to go down to X-ray). In this case, they may be given directions on how to get there.

For the moment, I'll concentrate on ii) and return to i) in a separate memo.

- Compliance with the instruction may be low. For instance, patients may not always do as they are asked. i.e. R4 Para 3 indicates that after triage, some patients fail to register. ("Not all the patients automatically go to the window to give their details in. A lot of them just sit down and then an hour later they come back to you and say 'what was it you told me to do?'"). Low compliance may be because they are confused or uncertain about what they are being asked to do (what is the influence of pain on this?).
- Success of the unaccompanied movement may be low. For instance, patients do inevitably get lost and spend considerable amounts of time wandering the corridors. They go to the wrong place on the outward part of their journey (e.g. to the fracture clinic instead of X-ray), or on the return part of their journey (e.g. back to the last cubicle they were in, rather than to the sub-waiting rooms).
- Negative feelings may be high. The patients may feel abandoned, frightened, confused, angry to be left, etc. This may lead to complaints and anger with staff (and the system).

Figure 6.2: Sample Memo Developing Properties  
and Dimensions of a Category

The memo shown in Figure 6.2, has started to give some conceptual density to the phenomenon of *unaccompanied patient movement on instruction by staff*. The aim of this sort of memo writing is to represent conceptually what the data reflect empirically (Martin and Turner, 1986). Whilst still grounded in the data, we can see that this memo begins to



become more abstract, moving from particular incidents to more general insights and conceptual ideas (in this case we begin to explore the ideas of *compliance* and *negative feelings*). In the next section, we will move on to show how we increase the levels of abstraction and conceptual density still further using axial coding.

#### 2.2.4. Summary of Open Coding

Open coding, then, is the analytic process by which concepts are identified and developed in terms of their properties and dimensions. The basic techniques by which this is accomplished are: the asking of questions about data; and the making of comparisons for similarities and differences between each incident, event, and other instances of phenomena. Similar events and incidents are labelled and grouped to form categories.

### 2.3. Axial Coding

Open coding fractures the data and allows one to identify some categories, their properties and their dimensions. Axial coding puts those data back together in new ways by making connections between a category and its sub-categories (Strauss and Corbin, 1990). Axial coding is, thus, concerned with the further development of single categories. It involves the intensive and concerted coding and analysis around the 'axis' of the category being focused upon (Strauss, 1987). However, although open and axial coding are distinct analytic processes, the analyst will typically alternate between the two modes during analysis.

Again, as indicated in the introduction to Section 2, axial coding is supported by the use of memo writing. *Code notes* support the task of forming connections. They are used to explore in more depth the features (conditions, context, strategies, and consequences) identified in the analysis. *Theoretical notes* extend the feature analysis (conditions, context, strategies, and consequences) by asking more detailed questions or drawing on new theoretical resources. Theoretical notes may also pull together several other memos into a summary. *Operational notes* may suggest further sampling, or list hypotheses to be checked out in the next interviews.

Axial coding specifies a category (phenomenon) in terms of some specific features of a category which are thought to give the category precision. These specific features are referred to as sub-categories. Sub-categories are related to categories through the use of a *coding model* that includes: the *causal conditions* that give rise to the category (phenomenon); the *context* in which the category is embedded; the *action/interactional strategies* by which the category is handled, managed, or carried out; the intervening *conditions* which facilitate or constrain those strategies; the *consequences* of those strategies.



The coding model is used to link and develop categories, and helps the analyst to outline the connections and relationships between categories in ways that explain the complexities of the data. These relationships, however, must be verified against the actual data, and during coding the analyst frequently returns to the data to look for evidence, incidence and events that support or refute the questions asked about categories and their relations. Instances of data are used to add variation and depth of understanding to the questions and statements. Also, while the analyst is examining the data, looking for evidence to support statements of relationships, s/he continues to watch for evidence of other properties of categories and the dimensional location of each incident that is coded. These are extra properties and dimensions to those identified during open coding. This expansion of specificity gives the analysis conceptual density, and helps to uncover as much variation as possible by allowing the analyst to note how clusters of specific properties of conditions, strategies, and outcomes pertaining to the phenomenon interact with one another to bring about differences.

### 2.3.1. Example of Axial Coding

In the following, we expand upon and exemplify axial coding and the use of the coding model by returning to our earlier example of *patient movement*. The usefulness of the coding model comes from the fact that it allows the analyst to order and relate the conceptual labels generated during open coding. For example, a conceptual label may, under closer examination during axial coding, turn out to be a condition for a category, or it may be the context in which a particular phenomenon occurs, and so on.

*Causal conditions* are the events or incidents that lead to the occurrence or development of a phenomenon. The specific properties of the causal condition can be used to explain the specific dimensions of the phenomenon under consideration. Causal conditions are often pointed to in the data by terms such as: when, while, since, because, due to, etc. For example, if we take the situation when a triage nurse sends a patient to X-ray, then the conditions that lead to the phenomenon of *unaccompanied patient movement on instruction by staff* include: the *time pressures* that prevent the triage nurse from escorting patients around the department. Such time pressures have a number of specific properties and dimensions such as: having to deal with levels of high *demand* (e.g. a constant stream of patients arriving in the department); having to work within specific *rules* which limit the amount of time spent on individual patients (e.g. the five minutes per patient specified by the Patient's Charter {Department of Health, 1992}); and having *other tasks* to perform (such as answering a telephone advice line).

*Context* can be considered from two perspectives. First, context represents the specific set of properties that pertain to a phenomenon along a dimensional range. Second, context is also the particular set of conditions within which the action/interaction strategies are taken.



Context, then, indicates further conditions under which future actions/interactions are taken. Returning to our example, we have already seen that time pressures lead to unaccompanied patient movement, now we need to know the context of that unaccompanied movement in terms of its: *duration* (e.g. how long the patient is moving unaccompanied through the department); its *location* (e.g. where the patient is); and its *success* (e.g. whether the patient is on-course or off-course).

*Actions and interactions* (among the actors) are directed at managing, handling or carrying out, or responding to a particular phenomenon. Actions and interactions have certain properties. First, they are processes, and can be studied in terms of sequences or change over time. Second, they are purposeful, and occur through strategies or tactics. As with conditions, there are cues in the data that point to strategies and tactics (i.e. the action-oriented verbs and participles). Returning again to our example, when patients have failed to find a particular location to which they have been sent, they often return to where they were sent from. We might call this phenomenon an *homing* strategy.

However, there are always *intervening conditions* that either facilitate or constrain the action or interactional strategies taken within a particular context. Intervening conditions are the broader structural context bearing upon a phenomenon. In our homing example, the *personality* of the patient may play a role in the success of the homing strategy. For instance, a very polite patient may return to the triage area from where they were sent, but may wait patiently for the nurse to become free again before they interrupt them. They may even rejoin the back of the triage queue.

Action or interaction taken in response to a phenomenon have certain outcomes or *consequences*. These might not always be predictable or as intended. The failure to take action/interaction also has outcomes for consequences. Consequences may be actual or potential. In our example, for instance, one consequence of the patients' homing strategy is that they may be 'missing' for a quite considerable time. Such an extended absence means that any departmental statistics will show that they spent an inordinately long time in the department during their visit. Such statistics have implications for future NHS assessments of the department. Furthermore, the consequences of one set of actions may become part of the conditions affecting the next set of actions/interactions. In our example, for instance, a nurse whose patient has been missing for some time may have to document the reasons, so that if she is queried by the hospital management she is able to *defend* herself against criticism.

In the example outlined above, we have shown how categories have been linked by means of the coding paradigm. Logic diagrams are sometimes useful for sorting out various relationships (Strauss and Corbin, 1990, provide many examples of such diagrams). Figure 6.3 graphically summarises some of the linkages developed in our example.

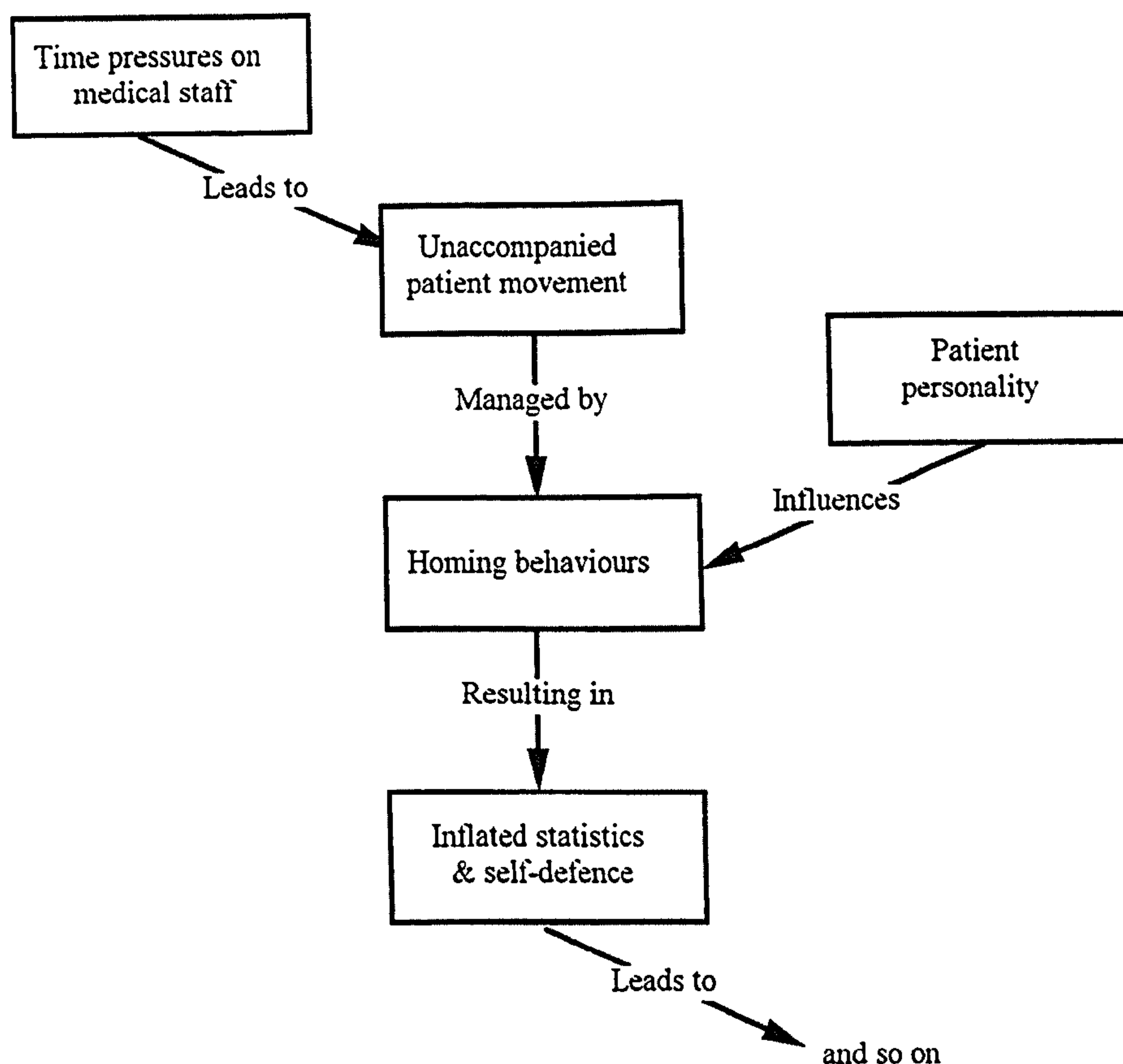


Figure 6.3: Example of Category Linkages  
Developed During Axial Coding

With such category relations in mind, we can then return to the data to look for more evidence, incidents and events that support or refute these relationships (Strauss and Corbin, 1990). In doing so, we may continue to develop these categories in terms of their properties and dimensions through the use of constant comparisons and the asking of questions about the data.

The analyst may also add conceptual density to axial coding through the use of memos. A theoretical memo (and a short operational memo which it generated) about patient movement is given below in Figure 6.4.



**MEMO: THEORETICAL NOTE & OPERATIONAL NOTE: Who has responsibility for unaccompanied patients?**

**DATE: 15/9/95**

**NOTES: Created During Axial coding of Interview R1**

**MEMO LINKS: Memo: Properties and dimensions of unaccompanied patient movement on instruction by staff**

**CARD LINKS: Card 21: Rules and regulations**

**Theoretical note:** Coe (1978) suggests that restriction of mobility is commonplace in most hospitals and gives two examples. First, patients are not allowed to leave their wards without the permission of the head nurse, who is usually required to know the location of patients at all times. Second, when patients do leave the ward to travel to other parts of the hospital, they are generally accompanied by a nurse, or an orderly. Coe (1978) suggests that the main reason for this type of restriction of mobility is that the hospital is responsible for patients whenever they are inside its walls. The result is that the ability of the patient to move about is supervised and controlled.

What conditions are different in the A&E department that contravene what on the face of it seems to be a sensible position to take? Surely, a patient wandering the hospital on their own is a liability both to themselves, to others, and to the hospital as a whole? Perhaps the hospital is willing to take limited risks in order to improve its efficiency? That is, by not using valuable resources for non-essential tasks. This view might be supported by the fact that the overall level of traffic in the hospital (by patients who do have to be transported either on trolleys or wheelchairs or helped by nurses) is so high (as suggested by Strauss et al, 1985), that resources are simply not available within a suitable time-frame.

**Operational note:** I should check out the legal responsibilities of the hospital for patients within its walls. Then, if necessary, follow-up exploration of reasons why such responsibilities may be waived.

Figure 6.4: Example Theoretical Memo  
(with Integrated Operational Memo)

As this theoretical memo shows, theory taken from the literature is viewed in the light of the data and the analyst's examination of it. That is, we are essentially interested in theory that proves to have some utility with respect to the analysis. This approach can be contrasted to fitting data to pre-existing theory (Turner, 1981).

### 2.3.2. Summary of Axial Coding

Axial coding is the process of relating sub-categories to a category. It is a complex process of inductive and deductive thinking involving several steps. The process is accomplished, as with open coding, by making comparisons and asking questions. However, in axial coding the use of these techniques is more focused and relates categories in terms of a coding model.

Axial coding results in a rich and dense understanding of categories in terms of their salient properties, dimensions, and associated relationships. The products of axial coding form the basis for selective coding.

### 2.4. Selective Coding

Selective coding is the process by which all categories are unified around a core category, and categories that need further explication are filled-in with descriptive detail (Corbin and Strauss, 1990). The core category represents the central phenomenon or the main analytic idea of the study. Selective coding, then, is concerned with integrating categories to construct systematically a picture of the situation that is conceptual, comprehensible and grounded in the data.

Again, as indicated in the introduction to this section, selective coding is supported by the use of memo writing. *Code notes* tend to be fewer in number (with the greatest concentration of efforts directed at theoretical notes). Code notes are likely to pertain mostly to the filling in of categories. *Theoretical notes* identify the core categories and integrate all other categories around it. The notes tell the descriptive story of the analysis. *Operational notes* tend to be very specific. They point to sources to validate findings.

Much as with axial coding, during selective coding, sub-categories are related to the core category as conditions, strategies, consequences and so on. There are five steps by which such relations are identified: explicating the story line; relating subsidiary categories around a core category; relating categories at the dimensional level; validating those relationships against the data; and refining categories that require further development. Again, these five steps are not sequential, and the analyst will move back and forth between them.

In the following, we expand upon and exemplify selective coding and by returning to our earlier example of *patient movement*, and show what part this category plays in the final analysis.

To achieve integration, it is necessary to formulate and be committed to a story line. A story line is a conceptualisation of a descriptive story about the central phenomenon of analysis which when analysed will become the core category (Strauss and Corbin, 1990). Typically, commitment takes the form of writing a short descriptive memo which highlights the essence of the study as perceived by the analyst. In this example, the author wrote a short memo as follows:



**INTEGRATIVE MEMO: Mismatch between demand and resources**

**DATE:** 15/7/96

**NOTES:** First pass storyline starting selective coding

Most of what I have seen and heard in the A&E department points to the fact that the medical staff (and particularly the nurses) are constantly battling to keep up with high levels of demand (in terms of patient numbers) given the fact that the resources of the department are limited (in terms of staff numbers). Let us call the phenomenon with which they are dealing: a *mismatch between demand and resources*. Given this phenomenon, their battle centres around: *reducing the mismatch between demand and resources*.

Figure 6.5: Storyline Memo

Once a description of the story has been written, the story must be told analytically, and just as with open and axial coding, that the core category has to be gradually related to other categories and developed in terms of its properties. In this example, there are two major properties which have already been touched on in the storyline, these are: *demand* (which is high); and *resources* (which are inadequate to meet such high demand).

Once the core category has been developed in terms of its properties, the next step is to relate other categories to it, thereby making them subsidiary categories. Relationships between categories are constructed by means of the coding model discussed earlier (conditions, context, strategies, consequences). The process entails arranging and rearranging categories in terms of the coding model until they provide an analytic version of the story. That is, categories can be arranged as conditions, context, strategies and consequences for the core category. Once the data are related at this broad conceptual level, the analyst continues to relate each category at the property and dimensional levels to add density and specificity to the construction.

Integrative diagrams are very useful at this stage of the coding process, as they help clarify the often complex relationships between categories and the core category. Figure 6.6 shows an integrative diagram used by the author to visualise the category relationships characterising the *mismatch between demand and resources*.

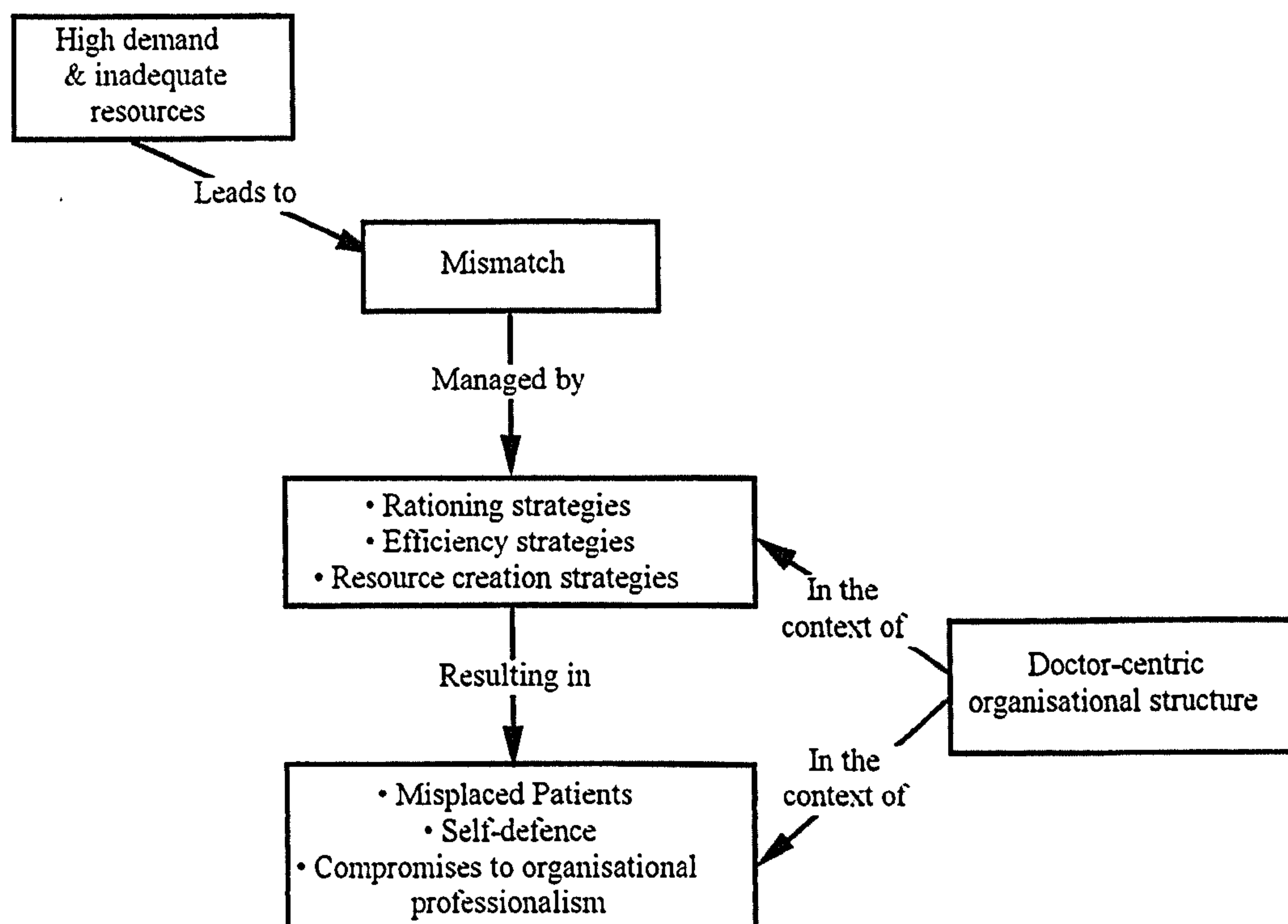


Figure 6.6: Integrative Diagram

Once we have an idea of how the categories relate to each other, and some organising scheme, we can then group all previous memos and analysis according to this scheme. Once satisfied that the theoretical construction holds up to scrutiny, we can go back to the categories and fill in any missing detail. Modifications and changes can be made in the statements until a general match is made. Typically, the analyst returns to the field notes (or to the field) to obtain data that allow these gaps to be filled. Filling the gaps, and providing more detail gives conceptual density to the construction, and also adds increased conceptual specificity, as well as supporting the validation of the categories and concepts with the data. Table 6.2 summarises the categories, the concepts that they embody and gives a brief note of the data on which they are based (see also Orlikowski, 1993).



CATEGORIES	CONCEPTS	DATA
Demand	Patient numbers	- closure of a nearby A&E department - closure of a local GP referral unit
	Attentional needs	- increasing numbers of inappropriate attenders
Resources	Inadequate staffing	- shortages of doctors/nurses - inadequate doctor/nurse ratios
	Inadequate facilities	- limited number of treatment cubicles
Mismatch	Waiting times	- typically 3-4 hours or more - increasing
	Complaints	- concerning waiting times - concerning care
Rationing Strategies	Discouraging attendance	- advice line
	Reducing information exchange with patients	- depersonalisation - doctors avoid interactions - reduction in sentimental work
	Reducing information exchange about patients	- interactions limited to medical necessity - limited informal communications
Efficiency Strategies	Special-purpose teams	- desk-doctor
	Role extension	- discharge and disposal - predicting information needs - re-routing of patients
	Doubling-up	- changes to resource use
Resource Creation Strategies	Special-purpose staff	- ECG technicians - medical doctors called in
	New roles	- nurse clinician
Organisational Context	Doctor-centric structure	- patient expectation - nurse as doctor's assistant - failure of multi-disciplinary teams
Self-Defence	Record annotation	- annotations to CAS cards - annotations to computer records
	Resource logs	- medical doctor to referred patient ratios
Misplaced Patients	Communication failures	- lack of up-to-date information - lack of 'public' information
	Unaccompanied movement	- lost patients - patients opting out of care - homing
Compromising Organisational Professionalism	Acting unprofessionally	- loss of patient confidentiality (short cuts) - loss of patient confidentiality (queues at triage)
	Perceived to be acting unprofessionally	- triage mêlée - sociality of nurses station - computer use replacing patient care

Table 6.2: Summary of Categories, Concepts and Data Associated with the Phenomenon of Mismatch Between Demand and Resources

Once, this stage is complete, the construction is laid out as a written memo of considerable detail. Such a construction follows in Section 3.

### 2.4.1. Summary of Selective Coding

Selective coding integrates the conceptual work done over the course of the analysis. Selective coding involves the construction of an analytic story leading to a picture of reality that is conceptual, comprehensible and grounded in the data. Central to this process is the selection of a core category, and the relating of all major categories both to it and to each other.

## 3. Output of the Application of the Grounded Theory Method of Analysis to Accident and Emergency Healthcare: the Report

In the preceding sections, we have provided a description of the Grounded Theory method and illustrated how it was employed in the analysis of the A&E department<sup>30</sup>. In this section, we present the fruits of that analysis in the form of a report. As indicated in the introduction to this chapter, this report represents a **particular conceptualisation** of the situation in the A&E department studied.

The major purpose of this report is to render an understanding of the situation in the A&E department that can be used to support the re-design of an healthcare information system. The report aims to achieve this purpose by systematically relating concepts and categories to provide a structure that faithfully reflects the organisational reality which the healthcare information system must address (via its re-design).

The report presents this understanding of an organisational reality in a format common to many types of qualitative research in that it includes selected illustrative detail in the form of quotes taken from the transcripts of the medical staff interviewed in the A&E department. This illustrative detail is used to convey the viewpoints of the staff, and to 'bring alive' analytic or conceptual points as they are made.

The report follows the storyline proposed in Figure 6.5, and in line with its primary purpose is titled: **Reducing the Mismatch Between Demand and Resources in A&E Healthcare: Some Aspects of the Social Organisation of A&E Work**

To help the reader orient themselves, Table 6.3 below is a table of contents that shows how the report shaped-up in relation to concepts and categories shown in Table 6.2, and the integrative diagram shown in Figure 6.6.

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<sup>30</sup> Of course, for reasons of space, these illustrations are only partial, and I have shown only a small portion of the analysis that lies behind the report. However, it is hoped that the reader is now in a position to see the manner in which the concepts included in this report were developed and related to each other.



**REDUCING THE MISMATCH BETWEEN DEMAND AND RESOURCES IN A&E  
HEALTHCARE: SOME ASPECTS OF THE SOCIAL ORGANISATION OF A&E  
WORK**

3.1. INTRODUCTION
3.2. MISMATCH BETWEEN DEMAND AND RESOURCES IN A&E HEALTHCARE
3.3. STRATEGIES FOR REDUCING THE MISMATCH BETWEEN DEMAND AND RESOURCES
3.3.1. <i>Rationing Strategies</i>
3.3.1.1. Discourage attendance
3.3.1.2. Reduce information exchange with patients
3.3.1.3. Reduce information exchange about patients
3.3.2. <i>Efficiency Strategies</i>
3.3.2.1. Special-purpose teams
3.3.2.2. Role extension
3.3.2.3. Doubling-up
3.3.3. <i>Resource Creation Strategies</i>
3.4. ORGANISATIONAL CONTEXT
3.4.1. <i>Doctor-centric structure</i>
3.5. CONSEQUENCES OF THE STRATEGIES
3.5.1. <i>Self-defence</i>
3.5.2. <i>Misplaced patients and tracking problems</i>
3.5.2.1. Misplaced patients: communication problems
3.5.2.2. Misplaced patients: unaccompanied movement
3.5.3. <i>Compromising Organisational Professionalism</i>
3.6. Summary

Table 6.3: Table of Contents for Report

### 3.1. Introduction

This report examines the mismatch between high levels of demand and the resources available in an A&E department of a major UK hospital. We characterise this mismatch in terms of its effects on patient waiting times, and consider some of the strategies used by medical staff to reduce the mismatch (and hence reduce waiting times). We also consider the consequences that these strategies have on the work of the medical staff in the department. Section 4 considers the contribution of this analytic report to the construction of requirements for the redesign of an healthcare information system.

### 3.2. Mismatch Between Demand and Resources in A&E healthcare

The number of people who attend hospital in the UK as an emergency is rising each year. Indeed, a three percent year-on-year rise in the early 1980s had become a five percent year-on-year rise by the mid 1990s. Consequently, A&E services are under great pressure to cope with demands that are out-stripping the resources available (Audit Commission, 1996; Goldsworthy, 1996).

The causes for increased demand are likely to vary from area to area, but might include factors such as: the increasing proportion of elderly people in the population; structural changes in employment; the fuelling of public expectation about the availability of health services and rights to them by the standards set out in the Patient's Charter (Department of Health, 1992); and so on.

National trends aside, at a local level, the medical staff suggested the following reasons for increased demand in this particular hospital: the closure of a nearby A&E department that has increased the overall number of patients in this hospital's catchment area; the closure of a local GP referral unit that has increased the number of medical referrals coming into A&E; and an increasing proportion of inappropriate attenders:

"one of the problems we have here, it may be a national problem, I don't know, but ... I get the impression that a lot of people attend hospital with things that, even three or four years ago, they may not even have considered going to hospital with."

To put this quote in context, Davison et al (1983) found in a study of the A&E department of a London teaching hospital that of the 587 patients attending in one week, 226 (39%) were not accidents or emergencies; and of these 67% were self-referrals who had not previously seen their GP, 21% were self-referrals who had previously seen their GP and 12% were referred by their GP. This sort of behaviour appears to still be commonplace:

"We tend to get a lot of people who say their GP's too busy. We also get a lot of people who say they rang their GP and he said come straight here, but when you contact the GP he's never heard from them. They're just assuming that, at some point, if the GP can't handle it, they'll then refer them to the hospital anyway, so this could all be why the department is really busy."

As well as factors which contribute to sustained levels of demand, the hospital also experiences peaks in demand which are largely due to its location in a densely populated metropolitan area. For example, the staff expect to have to deal with a number of violent crimes against the person after the bars close on Friday and Saturday nights.

Of course, high levels of demand may not be problematic if the resources available (including staff numbers, facilities and supplies) expand in line with them. From the point of



view of the A&E department considered here, there are two main resourcing problems. First, the ratio of medical staff to patients is often inadequate to deal with the large number of patients attending the department. Second, even at these inadequate staff to patient ratios, the department does not have enough facilities (e.g. treatment cubicles) to deal with the levels of demand placed upon them.

From the patients' point of view, the most obvious result of a mismatch between demand and resources are long waiting times (particularly for minors patients):

“On a good day they (the patients) might wait half an hour, an hour, on a bad day, five hours. We get more bad days now than good days”.

Long waiting times frequently lead to frustrated and even angry patients, which can result in arguments with medical staff (and in particular the triage nurses who occupy the most public position of all the staff). Although the staff are generally sympathetic to patients who have had a long wait, they may be less so when they believe a fractious patient to be an inappropriate attender anyway:

“We tend to see a lot of patients every day who've waited three or four hours. Their injury is the most significant injury in the world to themselves, so they get upset. Quite rightly so. You wouldn't want to wait that long yourself...but there's a number that shouldn't attend .. and you remember them more. And you end up having to spend a long time explaining things to them ... well actually sometimes you do end up arguing with them”.

Another consequence of long waiting times is an increasing number of formal complaints to the hospital management. Patients (and their relatives) may be more likely to complain nowadays, since many are aware that the Patient's Charter details their right to specific services within specified parameters. For example, the charter specifies time limits for receiving treatments, and indicates the information that should be provided to patients about those treatments, together with their risks and alternatives.

Long waiting times, frustrated patients and formal complaints are serious for the department as a whole, and for the individual medical staff, since they are recorded and analysed by hospital management and NHS auditors. In the next section, we will look at the strategies used by the medical staff to reduce the mismatch between demand and the available resources.

### **3.3. Strategies for Reducing the Mismatch between Demand and Resources**

In the face of a mismatch between high demand and limited resources, there are essentially three types of strategies which can be used: rationing of available resources; using the available resources more efficiently; and increasing the amount of resources available. These three categories are explored in more detail below.



### 3.3.1. Rationing Strategies

In the case of A&E, the major resource which is to be rationed in the face of high levels of demand is the *time* of the medical staff. Broadly speaking, then, rationing strategies can either try to discourage people from taking up medical practitioner time (for instance by discouraging them from coming into the department - see Section 3.3.1.1), or reduce the amount of medical practitioner time each patient consumes within the department (see Sections 3.3.1.2 and 3.3.1.3).

#### 3.3.1.1. *Discouraging Attendance*

One way of discouraging people from attending A&E is to provide them with remote assessment and advice (e.g. using a telephone advice line). The advice line is conceived as a way to offer a remote assessment of a patient's problem and make recommendations about suitable actions. For example, a potential A&E patient may only have a very minor injury that could be equally well treated by their GP or pharmacist. As such, the telephone advice line constitutes a way to stop people from attending the A&E clinic inappropriately (conversely, of course, it can also function as a way to ensure that those really in need do indeed attend A&E).

The patient's reactions to such lines may be mixed insofar as they may not believe that remote assessment is suitable, or that their illness could be so easily dismissed (if indeed it is). The advice line, then, needs to be handled with great sensitivity and concern for the patient's welfare. It demands an experienced nurse, and preferably one who has the time to spend on the patient's concerns. In the long run, however, the time spent on the advice line is likely to save both the department and the patient a lot of time and effort.

In the A&E clinic studied, the advice line is located in triage where the nurses are always suitably qualified to answer the call. However, the triage nurses are always under tremendous pressure, and the time and energy that they spend on each call and its documentation may be limited since they have more pressing concerns with patients actually queuing up outside their door.

The availability of an advice line is not advertised in the community, and currently relies upon calls being forwarded from the main reception desk. Even so, it still rings five or so times an hour. Presumably, then, it is currently being used by people who are willing to seek advice before coming in to the hospital. It also suggests that this line has more potential usefulness if it were more widely advertised (e.g. on local radio, under the hospital listings in the telephone directory and so on). This potential usefulness needs to be offset against the extra nursing cover that would be required to attend to it.



### 3.3.1.2. *Reduce Information Exchange with Patients*

One way to reduce the amount of medical practitioner time that a patient receives is to limit the amount of information exchange between the medical practitioner and the patient.

Here we distinguish three types of information exchange: medical, sentimental, and administrative. Medical information exchange pertains to a patient's illnesses and afflictions. Sentimental information exchange pertains to the psychological and social context of a patient's well-being (after Strauss et al, 1985). Administrative information exchange pertains to a patient's personal details (as specified in the NHS minimum data set).

There are essentially five ways in which the amount of information exchange with a patient can be reduced: the elicitation of medical information from the patient may be reduced; the provision of medical information to the patient may be reduced; the elicitation of sentimental information from the patient may be reduced; the provision of sentimental information to the patient may be reduced; and the elicitation of administrative information from the patient may be reduced (note that this information is not typically provided to the patient in any meaningful sense and so is ignored here as a sixth potential strategy). Each of these five strategies is considered below.

i) We might imagine that reducing the elicitation of medical information elicitation from the patient would be a risky strategy with respect to making an accurate assessment of patient's illnesses and their attentional needs. However, there is some evidence that this sort of information elicitation may be scoped according to the level of demand in the department. For example, a triage nurse commented that:

“ We are able to spend less time with a patient in triage now, and I don't think that the new triage system is very good for the patient. It meets the Patient's Charter, but it's not necessarily good for the patient, because if you've got ten people to book in, you're not going to take as much information because you can see you've got a big queue. You're going to say, 'you've got a pain, you've hurt your arm' that's it, rather than 'how did you hurt it, how long ago, will you put it up in the air, have you got a pulse there?', this kind of thing”).

This quote also illustrates that the triage nurse does not find this a satisfactory situation, but is aware that time pressures simply do not allow sufficient time for all the assessment tasks that she believes to be desirable (over and above an obligatory minimum).

Triage nurses have a number of ways of communicating with a patient from the moment they first see them. They ask questions of the patient to obtain a brief history (what they have come in with); they listen to the patient to hear what they are complaining of; they observe the patient looking for general and specific indicators of illness (pallor, pain levels, obvious injuries and so on); they also touch the patient, often in conjunction with further



questions (e.g. lifting an arm and asking the patient: "does this hurt?"). In periods of high demand, the use of any of these different ways of eliciting information may be restricted.

In the case of patients who are brought in unconscious or gravely ill, and unable to give any medical details (and their are no relatives to supply those details), doctors and nurses will attempt to make quick guesses based on age, gender, clothing, cleanliness, and so on to fill in the gaps (for instance, is this person in a diabetic, an alcoholic, or a drug induced coma?).

Finally, we should note that the way in which information is recorded may also have an effect on information exchange between patients and medical staff. For instance, it has been reported that clinicians of all types report that their social interactions with patients are more satisfactory when they use pencil and paper (rather than a computer) to record details (e.g. Morgan, 1991a). Using a computer appears to have a number of effects in this context. First, the flow of information between the patient and the clinician may be disrupted, since extra attention is needed to use the computer and type in the information. Second, the fixed position of the computer on the nursing station or desk means that the clinician has to turn away from the patient in order to record information. Third, the use of the computer appears to formalise the interaction in a way that sometimes militates against the patients exposing their 'real' problems.

ii) Reducing the provision of medical information to the patient is also a common strategy (particularly on the part of doctors). A number of surveys have indicated that patients are dissatisfied with the lack of information and explanation they receive about their illnesses and treatment (Cartwright and Anderson, 1983; Morgan, 1991a). Again, there is some evidence in this study to suggest that from the doctor's point of view limited interactions with patients are routinely used to save time, as the following quote from a senior sister illustrates:

"They (the doctors) are encouraged to stay in the cubicles. They don't like it because the patients irritate them, I think, because they ask them too many questions."

iii) The elicitation of sentimental information from the patient may be reduced. In the A&E department, sentimental work mainly involves the medical staff finding out about aspects of the patient's life and personal history that may be important with respect to their care (both in the department and on discharge).

For example, an abusive alcoholic patient with a minor injury, will be treated differently to an abusive alcoholic patient with a minor injury whose mother is known to have died recently. The medical outcome may be the same insofar as their minor injury is treated, but the patient will be handled more sympathetically, and specialist help (e.g. a social worker) may well be obtained to assist during the process.



However, the amount of sentimental information elicited is related to the severity of the patient's injuries, and their concomitant attentional needs. For instance, it is almost absent on minors where interactions with patients are often kept to a bare minimum. On majors, communication is often more extensive since the attentional needs of the patients are greater, and nurses (in particular) will almost inevitably be spending more time with them. For example, in some cases nurses may stay in the cubicle with the patient, and in others they may take responsibility for a number of patients on one side of the treatment area and look in on them periodically. The nurses are more inclined to invest time in majors patients, since many of them are regarded as 'poorly' and, therefore, deserving of more attention. Learning more about a patient's life also provides the medical staff with information that they can use to help the patient through difficult moments during their treatment (e.g. pain, or fear of investigations or treatment and so on - Strauss et al, 1985).

iv) The provision of sentimental information to the patient may be reduced during periods of mismatch between demand and resources. In this case, staff are focused on the immediate medical problem, and may reduce their interactions with patients to a brusque matter-of-factness where they may not even know the patient's name. This sort of strategy is common on minors, as the following quotes from two different nurses illustrate:

"I mean it's quick turnover on minors, people are in and out, you don't really keep track of the actual names;"

and:

"in minors you don't know anybody. It's awful, they just get to be an arm or a leg. They don't get to be a person anymore").

Aside from the loss of identity, and perhaps more importantly, medical staff may not provide the patient with any psychological or emotional support during their assessment or treatment. For example, they may not prepare them for an action that may hurt or offend, or they may not talk them through a painful procedure.

However, in general, we should note that from the patient's point of view, such depersonalisation (Morgan, 1991b), lack of communication, and lack of polite interaction is a source of much chagrin and complaints (Audit Commission, 1993).

v) In contrast to the strategies above, the elicitation of administrative information from the patient is seldom reduced because the collection of such information is governed by national requirements in line with a standard NHS data set (including personal and biographical details). The details are used to identify the patient unambiguously, to keep records of important details (such as a child on the 'at risk' register or a drug user), to set up after care with the GP, and for hospital statistics and funding regimes. More importantly, such biographical details also have a role to play in the diagnosis process, since they also



provide an indication of previous attendances (which provide the context of a diagnosis for the doctor).

For the walking wounded, the clerks will gather these data from behind a glass-screened reception desk. Patients are asked a series of questions (normally in quite rapid succession) from a *pro-forma* on the computer system. Many of the patients do not always know the answers to some of these questions, though they can be assisted by the receptionist on occasion (e.g. in identifying their GP; or finding the postcode of their next of kin). The receptionists are all skilled typists and skilled in the use of the computer system that pertains to their job.

For ambulance patients, the receptionist will come out of the reception desk and get as many relevant details as possible from either the patient or their relatives. Details are collected using a paper-based system, and details are copied onto the computer later. This work may be done in the moments between triage assessment and investigations.

In general, though, however it is done, this type of administrative work is seldom not completed.

#### 3.3.1.3. *Reduce Information Exchange about Patients*

Medical staff can also save time by limiting the amount of communication and information exchange between themselves about a patient to the minimum that is necessary to expedite their medical care. In such cases, sentimental information that may have an effect on how patients are handled during their visit (but only a limited bearing on their medical assessment and treatment) is not exchanged (even though it may have been elicited).

Sentimental information is typically passed between staff as an informal communication. A typical time for such informal communication to take place is when a nurse from a treatment area comes down to triage to pick up the CAS cards of the next batch of patients. A triage nurse described this activity as:

“A time when you can hand over all the little bits of information that you haven’t got a chance to write down, but will have some bearing on their care. Where their relatives are, and things like that. Whether they’ve got the keys to their flat, or whether they forgot to bring them. I mean, if you send him home in an ambulance, you’ve got to make sure he has his keys, that kind of thing, so it is quite important.”

During periods of high demand, however, there isn’t time for this type of informal communication between nursing staff:

“Quite often, the triage nurse is so busy, minor injuries people come in, take top half-dozen (CAS cards) and off they go....You don’t get much time to do a handover really, you could do with a bit more time to do that.”



So, not only is sentimental work often not done, but sometimes even if it is done, it is not communicated to other staff.

### 3.3.2. Efficiency Strategies

Another group of strategies which are used by the medical staff to cope with high demand are called here *efficiency strategies*. Broadly speaking, efficiency strategies are ways to increase productivity or make better use of the available resources (again in particular the *time* of medical staff). A number of such strategies are considered below.

#### 3.3.2.1. Special-Purpose Teams

During busy periods when there is a 'bit of a wait up' doctors and nurses may attempt to increase their productivity. Productivity in this sense refers to the speed at which they 'process' patients, and means that assessments and treatments have to be performed more quickly without a decrement in the quality of those assessments and treatments.

Increasing productivity may not simply be a matter of working harder or faster, but may demand a new strategy that is not used under normal circumstances. For example, in the minor injuries treatment area a strategy that is only used in periods of high demand is to form a special-purpose team to deal with the minor injuries of patients who don't need to undress much in order to be examined (e.g. patients with hand or foot injuries).

This special purpose team typically consists of a doctor and a nurse who is dedicated to that doctor (rather than being available to all doctors on the minors team). The doctor will typically sit at a desk, and let the patients come to him for assessment. This strategy can be contrasted with the normal mode of working where nurses take a patient to a cubicle and the doctors then go to them (this strategy is still used for patients who have to undress more).

In the first instance, patients will be allocated to the desk doctor on the basis of their triage information. The doctor will make the necessary assessment and treatment plans, and handover the patient to the dedicated nurse for treatment. The nurse has a reserved cubicle in which to place them.

This strategy may have implications for the rest of the team, who may now have to respond to other contingencies (e.g. worried relatives seeking information on the telephone). From the patient's point of view, their treatment is less confidential than if they were being seen in a cubicle, but given the nature of their injuries and the alternative of a long wait, this strategy appears to be acceptable to the patients (there are few complaints specifically about this strategy).



### 3.3.2.2. *Role Extension*

Another way for the medical staff to increase their productivity is to extend their roles to encompass jobs that are not strictly speaking part of their own work. Such role extension is typically used to avoid potential bottle-necks. Role extension can be strategic or tactical.

Strategic role extension involves changes to the overall organisational policy governing particular roles, and how they are performed. Strategic role extension primarily occurs because of structural changes. For example, the A&E department is trying to implement the concept of a 'multi-disciplinary team approach', where any member of staff is encouraged to take responsibility for particular tasks such as taking ECGs, blood specimens, blood pressure and so on. The ethos of this approach is that whoever is least busy, be that either a nurse or doctor, should do such tasks (see Section 3.4 for the conditions which govern how this approach actually works in practice).

Tactical role extension is essentially a personal decision to extend one's role to take account of immediate priorities with respect to the efficient use of current resources. For example, doctors may dispose of patients from the computer while all the nurses are occupied in either treating patients or bringing through more patients for the doctor to see:

“Speaking for myself (as a doctor), if the nurses are busy, and there are CAS cards lying there waiting for disposal, I'll go through them and put them on the computer. That's it though, as far as I'm concerned”.

Role extension can also take place more widely throughout the department as a whole. For instance, triage nurses may try to predict the information needs of doctors in the treatment areas and either take responsibility for certain actions (particularly investigations) or collaborate with the doctors to improve the efficiency with which a predicted event is accomplished. For example, if a triage nurse thinks that there is a likelihood that a doctor in majors will order an X-ray and there was going to be a delay before the doctor saw the patient, they would mention it to the doctor and get the doctor to sign the X-ray forms. The result of such role extension is that when a patient eventually gets to see a doctor for assessment, the X-ray investigation is already available to support the diagnosis.

Role extension, however, is a complicated phenomenon that depends on a number of intervening conditions such as the personality of the staff involved, their personal relationships, their attitude to their role and so on. The last quote (paragraph three of this section), for instance, shows the limits to which one doctor is prepared to go.

Role extension may be particularly dependent on the context in which the work is being carried out (see below). Where the context may include: the type of work being negotiated (e.g. taking bloods); the skills and status of the worker being asked to do a job (e.g. whether a doctor or a nurse); and the personal *relationship* between the co-workers (e.g. familiar team members versus unfamiliar non-team members); and so on.



The decision to extend one's role is also influenced by: *empathy* with other members of staff when it is clear that they are under pressure (e.g. triage is considered to be a 'war-zone' and a 'hell-hole' and most members of staff will go out of their way to help triage nurses); *coercion* by other members of staff (e.g. by pulling rank); and *negotiation* (such as making a deal that recognises the future self-interest of the co-worker, reaching an informal agreement, and so on - see Strauss, 1963).

### 3.3.2.3. Doubling-Up

A way for medical staff to make better use of the resources available is by removing any bottle-necks to productivity, such as the availability of treatment cubicles. That is, during busy periods the strategies governing the use of resources may change.

For example, during quiet periods a majors patient may stay in a cubicle while awaiting the results of tests. However, during busy periods, when there is competition for cubicles, these patients (who are typically not in danger) may be moved out of the cubicles and may wait instead on trolleys or in wheelchairs in the holding bay (and occasionally) the corridor:

"If you physically need a cubicle for a patient that's come in, then you're going to have to make room for them. Which means that you're going to have to pull out the patients who may be just waiting for blood tests, results, for a doctor to make a decision... so we double-up basically. In which case we have to pull people out, and wherever there's space on majors, maybe down the corridor, we'll leave the patients."

The nurses and the patients know that this procedure is non-optimal, and it is only used when necessary. Patients may become uncomfortable (if they have to sit in a wheelchair for a period of time, say) and they may feel aggrieved at the loss of privacy and security that being safely housed in a cubicle with the curtains drawn affords them. From the medical staff's point of view, the strategy is non-optimal in that it is harder to monitor and respond to changes in patients since the places in which patients are left do not have built-in facilities (such as oxygen), and it is harder to move around in an overcrowded treatment area. Also, as indicated in Section 3.5.1, the nurses may feel that their professional image is compromised, particularly if relatives are brought through to see a patient.

When workload in majors is very high, and even doubling-up patients fails to keep pace with demand, then some patients who we might think of as less ill majors are re-routed and seen in minors:

"Otherwise, you end up with a situation sometimes when minors get seen far quicker than the majors. If you think about it, it's completely wrong. Someone with an injured wrist shouldn't get seen before someone with chest pains. So you end up stopping them sending to majors, giving a few to minors, and then the people with minor injuries just have to sit and wait."



As this quote shows, attentional need (that is, the seriousness of the patient's illness has precedence over demand *per se*). This re-routing of patients has knock-on effects insofar as the minors patients then have a very long wait, which can lead to frustration and complaints.

### 3.3.3. Resource Creation Strategies

Getting extra resources to help with high demand essentially means increasing the number of staff available to assess, manage and treat patients. There are two structural strategies that have some impact in this regard: bringing in extra special-purpose staff; and the relatively new role of the *nurse clinician*<sup>31</sup>.

Extra technical staff may be brought into the department to play specific and limited roles. For example, on majors, an ECG technician is called to take repeat ECGs. He or she will come from a specialist ECG department, and they are on call 9-5 weekdays. Outside these times the nurses have to do them. In practice, A&E nurses will tend to do the first reading, and then call the technicians to come and do the repeat ECG at specific pre-planned times.

Extra medical staff may also be brought in for more general purpose roles, but each decision to generate additional resources (bringing in more doctors) is not taken lightly given the organisational and financial pressures suffered by the whole hospital. One solution to this problem has been the creation a new role called the nurse clinician. A nurse clinician is able to do some of the jobs normally performed by doctors (such as ordering X-rays), and has taken a special qualification for this purpose. There are a set of very rigid protocols about what kinds of injuries a nurse clinician can assess and treat.

## 3.4. Organisational Context

This section examines some features and conditions of the organisational environment that have a bearing on the strategies used to cope with high demand in A&E. These features may act to facilitate or constrain the way in which the strategies are carried out and managed.

### 3.4.1. Doctor-Centric Structure

Although much of the work in co-ordinating the activities of the A&E department is done by the nursing staff, the central focus of the medical work inevitably lies with the doctors. It is the doctors who determine what treatments are appropriate based on their diagnoses and assessments, and it is the doctors whom most patients arriving in the department come to see. Indeed, many patients (particularly inappropriate attenders) will not accept the judgement of a nurse about their illness (even if they have seen a senior nurse

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<sup>31</sup> Sometimes known as *Emergency Nurse Practitioner*



or a nurse clinician), and may insist on seeing a doctor even when told they will have to wait for some considerable time. One doctor speculated that this insistence on seeing a doctor may be related to the patient's need to leave with a diagnosis:

"They've come to hospital and they want to know exactly what's wrong with them. I don't suspect they require or they expect to get treatment, but I think they all want to be able to go home and say: 'this is what I've got'. Unfortunately you cannot do that in all cases. There's a vast majority of people that even specialists can't diagnose. You've just got to treat them as best as possible. You say 'I'm not really sure why this is' and try and explain it as best as possible. Sometimes you get the feeling that patients are a little let down that there's no diagnosis. They wonder: 'well what's wrong with me'?"

The relationship between doctors and nurses is a very complex, and there has been a substantial amount written about the nurse as the physician's assistant (Reverby, 1986); nurse-doctor game playing (Stein, 1987); problems of gender and professionalisation (Schwartz et al, 1987); and so on. Our aim here is not to consider such general perspectives, but to concentrate on those elements of the doctor-nurse relationship that affect the strategies that the A&E team uses to handle high levels of demand within given resource constraints.

For example, the A&E department managers have tried to implement a *multi-disciplinary team*<sup>32</sup> approach which encourages a sense of shared responsibility amongst the staff. A charge nurse remarked that:

"Our A & E department works, is supposed to work, as a multi-disciplinary team approach, which means if you've got patients who needs certain things doing like observations, blood pressure, pulse, needs an ECG, needs blood specimens taken, then it's whoever is available at the time who is least busy, could be a nurse or doctor. That is supposed to be our philosophy, but in effect it just means the nurses do it because the doctors consider themselves above it, but that's what we've been told, that's the way it's supposed to work".

As we can see, the ethos of a multi-disciplinary team has not been taken on-board in practice by the doctors (at least in the context of this particular hospital). This view was corroborated by a junior doctor, who indicates that much of this is to do with personal attitude rather than a particular organisational culture:

"If you need to do investigations like blood tests, a lot of doctors will ask a nurse if they'll do it, but again, it's just running the nurse down from the job she's doing and you're the person with the patient. It takes literally a minute to take a sample of blood. You may as well get on and do it

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<sup>32</sup> The concept of 'discipline' in this context is used somewhat informally to characterise professional differences in role between doctors, nurses and other professions allied to medicine.



yourself, rather than cause delays elsewhere in the department. But not everybody has that attitude”.

This feature of the doctor-nurse relationship becomes even more strained with respect to organisational and administrative tasks. For instance, many doctors view their role as essentially one of medical care, and co-operation with the nurses in the co-ordination of that care is rare. In this sense, it falls to the nurses to ensure that the patient is in the right place at the right time to be seen by the doctor. As one nurse put it:

“All they (the doctors) are interested in is seeing the patients, basically”.

This situation is compounded by the fact that many of the administration and co-ordination tasks are done on the computer system. For example, as one charge nurse put it:

“It’s very rare that a doctor would use the computer... A couple may use it to do discharge, that’s the only reason. They won’t use it to see what’s going on at the moment... They don’t see that as their role, you see”.

This view is corroborated by other nursing staff:

“They (the doctors) don’t see it (using the computer) as medical, they see it as purely admin. ‘I’m here to be a doctor, not to do admin...’ I think they see it as admin, below them.”

Finally, however, we might note that some of the doctors are aware of this aspect of their teamwork (even if they do not want to do anything about it). As one junior doctor admitted:

“The doctors leave a lot of loose ends in their work, you know, prescriptions here, X-rays over there, patient somewhere else. The nurse has to glean all this together, assimilate it all and then place the patient where they’re meant to be, either discharged home, sent to a ward, or whatever. Again, they tend to be picking up a lot of the mess that we leave”.

Clearly this doctor-centric structure has an effect on the way the strategies described in Section 3.3 are performed. For example, the strategy of *role extension* plays a relatively minor part in reducing the mismatch between demand and resources since doctors are not interested in extending their role too far. *Special-Purpose Teams*, on the other hand, are more successful since they typically follow the authority and demarcation lines laid down by the doctors. *Reducing communication about patients* also has a greater effect insofar as this suits the doctors’ normal style of working.

### 3.5. Consequences of the Strategies

The strategies outlined in Section 3.3 contribute to a reduction in the mismatch between demand and resources. However, they also have a number of consequences for the A&E team which are considered below.



### 3.5.1. Self-Defence

When the strategies for reducing the mismatch between demand and resources fail (and waiting times remain long), the nurses have to make sure that they are able to protect themselves from the negative consequences of the resulting patient complaints.

Medical staff sometimes have to face complaints against themselves or the department. Although both doctors and nurses do sometimes have to face complaints against their clinical competence, it is the nurses who mostly have to face complaints about their organisational competence, and in particular complaints about excessive waiting times in the A&E department by patients and their relatives. Nurses become the focus for such criticisms because it is they who are primarily responsible for the co-ordination of departmental activities relating to the flow of patients through the department (whilst doctors are the recipients of those patients at some point in time).

Complaints may occur whilst the patient is *in situ*, or they may occur many weeks later when a formal complaint is filed with the management. In order to be able to defend themselves when such complaints arise, nurses have to ensure that they always have a basis for their defence. To protect themselves, then, the nurses keep records of the reasons behind any situation or event that may at some point in the future give cause for complaint. These records can be used later to explain those situations, and justify the actions of the staff.

There are two types of record keeping: annotating a patient's documentation and computer records with comments; and keeping logs of resource limitations.

One example of document annotation is the appending of explanatory notes to a patient's CAS card:

"We have to document a lot, but that's only for your own and the patients' benefit, just waiting times and delays. But you do that as you go along.... you write it up on CAS cards to cover your own back so you won't get complaints back later on... it has to be done for any of the patients, so you can go back to the card...and it's down to you, if you sign that person, your name's on that card somewhere, they'll come to you. Then you can get called into the office, probably about six weeks, two months later, and asked 'why was this person in the department so long?' You can say, well they were medical number 2 priority, but then they got pushed down...or the doctor was busy in resuss...so you know there's a problem there with the ward, not the nurses".

Keeping logs of resource limitations is also important for self defence. For example, a referred medical patient (that is, sent to the hospital by a GP) may be demoted down the waiting list to make room for a casualty patient who now needs to see a medical doctor. Such revisions to a patient's priority occur because, at that time, the casualty patient will have been in the department for longer than the patient referred by the GP. These referred patients may then complain about their waiting time. To defend themselves against such complaints, the nurses keep a list of the number of medical patients that are in the



department each hour and a record of how many medical senior house officers (SHOs) are down from the wards to deal with them:

“What we (the nurses) were saying was that medical doctors kept disappearing off the department to go to the wards, because they have ward responsibilities, so they have to keep an eye on those as well, and each time there’s a cardiac arrest in one of the wards they’ve got to disappear, and each time this happened, we were getting less and less doctors on the department, medical doctors, and it was their patients which were waiting. I’ve seen medical number 17 waiting to come into triage. So that person’s going to have five or six hour wait in triage before seeing a doctor. So that’s why we said, ‘right, we’ll keep a record of how many medical doctors there are in the department and how many patients are waiting’. We’ve got one doctor with only two patients, then fair enough, but when we get to medical 17 there really should be more doctors in the department”.

As mentioned in Section 3.1, the high number of referred patients is a result of a structural problem insofar as the use of separate GP referral units has now been discontinued in this region. In general, the medical staff expressed a wish to get rid of the GP referral system altogether.

More seriously perhaps than the need to defend themselves against complaints about waiting times, the nurses may also have to defend themselves with respect to the care of patients. For example, a patient must always be seen by a nurse before leaving the department, so that the nurse can assess the social situation of the patient (e.g. have they got the keys to their house with them), and their transport needs (e.g. do they need an ambulance to get them home). This rule, however, is often broken and patients may get sent home by doctors who then leave the patient’s CAS card by the computer system for the nurses to complete the disposal:

“So I come along and find twelve (CAS cards) there that I’ve got to book out and I don’t know when they (the patients) went, but then again that comes into accountability, I’ve not seen them go, but my name’s on the computer, so therefore I’m the person whose responsible for letting that person go. So you then end up writing on the card ‘discharged by doctor - not seen leaving by nursing staff’ to cover your own back, which is awful. But otherwise, my name’s on that computer as discharging them”.

In this case, then, notes are appended to the patient’s CAS card as a way to defend oneself against personal attacks on competence. Similarly, nurses pay special attention to logging out of the computer, knowing that the next nurse will be very tempted just to carry on under their name if they are not logged-out (because of the time it saves). Many nurses will log-out colleagues if they have forgotten, but inevitably there is often a temptation to just carry on under that person’s name.

The time spent on these self-defence strategies may have implications for the nature of medical work and particularly care work (such as comfort work and sentimental work). One



implication is that nursing resources are taken away from care work. Another implication is that the nurse's perception of patients may be altered, and this may have a deleterious effect on the amount of energy they are prepared to invest in patients. It may also promote negative feelings towards the organisation which may be perceived as not supporting them. It may also lead to poor co-operation between nurses and between nurses and doctors, particularly when those doctors are not full-time members of the A&E team (as we have seen above in the case of medical referrals and medical SHOs).

### 3.5.2. Misplaced Patients and Tracking Problems

The strategies of *reducing information exchange about patients* and *reducing the information exchange with patients* are often successful in saving medical practitioner time. This saved time, can soon be lost, however, since these strategies also lead to a problem in tracking patients through the department.

It is important for A&E staff to know the whereabouts of patients for two major reasons. First, the flow of patients depends on the ability of staff to locate a patient and move them about the department as required (e.g. from the waiting room to a treatment area, or from a treatment area to X-ray). Second, when a telephone enquiry from a patient's relative is received, the nurse needs to be able to locate the patient to be able to provide accurate information about the current state of their care. Telephone enquiries are a frequent occurrence (up to ten per hour in minors, and more than fifteen per hour in majors), and they become even more frequent during busy periods for the simple reason that there are more patients in the department.

Despite the need to know their whereabouts, patients may often become *misplaced*, which broadly speaking means that the location of the patient is not known for a period of time. There are three important senses in which patients may be misplaced. The first is that the patient is in the right place in the department (e.g. X-ray), but a nurse does not know their location. The second is when the patient is simply in the wrong place (e.g. the fracture clinic) in the department. The third is when, unknown to the nurses, the patients have left the department (e.g. gone home because they are fed-up with waiting). The first type are mainly a result of communication problems between staff. The second and third types are mainly the result of the unaccompanied movement of patients about the hospital. Both of these types of problem are considered below.

#### 3.5.2.1. *Misplaced Patients: Communication Problems*

Communication problems associated with misplaced patients tend to be due to a lack of up-to-date and/or public information about the whereabouts of patients (that is, public in the sense of being available to all the medical staff).



An example of a problem caused by the lack of public information can be found on minors. Here, a doctor may send a patient to X-ray without informing any of the nursing staff and without making any record of this instruction:

“Particularly in the minors, because there’s such a large stack (of CAS cards representing actual patients), and we don’t have the patients’ names written down somewhere like we do in majors, telling us who’s in what part of the department, trying to locate them is difficult. They could be in the sub-wait, seeing a doctor from there, or they could be in a cubicle, depending what’s wrong with them, or they could be down in X-ray. There’s absolutely no way of knowing, we don’t trace a patient in minors”.

When a telephone enquiry is then received about that patient, the nurse has no idea where they are, and may go round each of the treatment cubicles, or even walk down to X-ray, to look for them.

An example of a problem caused by the lack of up-to-date information can be found in triage. Here, a patient’s triage status is public in that there is a computer record of where they should be going (e.g. to majors or minors), but no record of whether they have actually gone there yet (i.e. they could still be in the waiting room). Here again, when a telephone enquiry about a patient is received (typically at the reception desk in this case), a clerk will have to leave reception and go to triage to sort through the CAS cards (if the patient’s card is not in the stack, then the patient has gone to their designated treatment area), or talk to the triage nurses themselves. Once a clerk has established that a patient has gone through, they then have to put the call through to that treatment area for the nurses there to deal with.

#### 3.5.2.2. *Misplaced Patients: Unaccompanied Movement*

Patients are sometimes responsible for their own movement around the department. Typically, a member of staff will tell the patient where to go and give them directions on how to get there and where to return to. However, patients do not always take notice of where they are (and are unlikely to have the same functional divisions of the department as the medical staff), or they may be distressed and distracted by their injuries. Given responsibility for their own movement, then, patients may lose their way or end up in the wrong place. The following are some common ways in which patients get misplaced:

- on returning from X-ray, they may go to the fracture clinic instead of returning to A&E (after all, sometimes they do have a fracture);
- on returning from X-ray, they may not inform a member of staff that they have returned, and may sit patiently in the minor’s sub-waiting room for some time until they are spotted by nurses;
- they may return to the waiting room instead of registering after triage (hence failing to get into the system at all)



- they may opt out of care and simply leave the department because they are fed-up with waiting;
- they may occupy the last treatment cubicle they were in (if they are lucky enough to find it empty)

Misplaced patients (of all types) have a number of undesirable consequences. Patients may feel disorientated, frustrated and confused about what they are supposed to do next. Ultimately, of course, they may also feel dissatisfied with their care in A&E, and may make formal complaints. From the department's point of view, misplaced patients disrupt patient flow, and may compromise patient statistics since the time spent in department will be longer than necessary. More importantly, misplaced patients may also compromise the care of both themselves and other patients, since nurses have to spend valuable time searching for them. Similarly, the work of both A&E staff, and staff in other parts of the hospital (e.g. the fracture clinic) may be disrupted. Also, as mentioned in the introduction to this section, the nurses may not be able to provide relatives with suitable responses to their enquiries, which may, in turn, make the department appear disorganised, leading to worry and complaints from relatives. Finally, as we shall see in the next section, trying to save time that may be wasted on misplaced sometimes leads to nurses to compromise a patient's confidentiality and their own professionalism.

### 3.5.3. Compromising Organisational Professionalism

The strategies of *reducing information exchange about patients* and *reducing the information exchange with patients* often militate against the maintenance of high standards of professionalism. In the A&E context, nurses in particular have two worries about their professionalism. The first is that they actually may be acting in unprofessional ways. The second is that patients and their relatives may perceive them to be unprofessional.

Acting unprofessionally can be divided into two types, depending on whether or not they have personal control over the actions which they consider unprofessional.

The following is an example of unprofessional behaviour over which the nurses have control should they choose to exercise it. During busy periods, a nurse may behave unprofessionally in order to save time. They may be aware in such cases that they are behaving unprofessionally, but feel under the circumstances they have no choice. Taking a telephone enquiry in minors provides a good example of such behaviours. In minors, the patients are not known by name, and as we have seen in Section 3.5.2, they may be misplaced or *en-route* to X-ray, and the nurses consequently need a quick way to establish whether a patient is there:

“Sometimes you just end up standing in the middle (of minors) shouting ‘Is there a J. Smith here?’ It’s easier than running around, I mean it’s not



professional but sometimes you have to do that. See, our X-ray is half-way down there, so it's a bit of a trek."

The nurses are aware that such behaviour compromises patient confidentiality, but consider it necessary in order to save time. This behaviour has become almost common practice in the department, even though many nurses have distinct reservations about acting in this way.

There are other situations, however, when the nurses are aware that their actions are unprofessional but they have little or no control over this fact. For example, a new triage system that was introduced to meet the Patient's Charter recommendation that all patients should be triaged in under five minutes means that patients now queue at the triage desk rather than waiting in waiting room until they are called:

"Patients used to back up outside the clerk's desk, which was not quite confidential because they ask about address and name, but it's nothing particularly personal, whereas now backing up at the triage desk, the next person behind knows your personal problem. I don't think it's necessarily very good for the patient, but there again it meets the Patient's Charter."

Despite these instances, nurses are very concerned that the image both they and the department portray to the outside world (primarily patients and their relatives) is a professional one. The professional image they seek to portray is one of calm and controlled efficiency. However, in periods of intense demand these characteristics are elusive.

As we have seen in Section 3.5, communication problems and misplaced patients may lead to phone enquiries from relatives being shunted from the clerks to triage to one of the treatment areas and back again before the patient is located. As one nurse put it:

"I don't like it when the relative or the enquirer is messed about... it looks as if we're not efficient".

The physical characteristics of the environment, and the way that the work is organised within that environment, also plays a part in the image portrayed by the department. For instance, in triage which has limited space, a busy period turns into a *mêlée* where, for example, there may be two nurses, a clerk who has come out to take registration details of a patient brought in by ambulance, the patient's relative who has travelled with them, the ambulance driver, nurses coming through from majors or minors to pick up CAS cards, a senior nurse coming through to answer the advice line, other nurses looking after patients in the holding bay, a patient at the door waiting to be assessed, tens of registration slips, and CAS cards streaming out of the printer. As one triage nurse put it:

"During a very busy period we have quite a lot of CAS cards being printed... they come in a spurt, you suddenly get ten people booking in and you've got six ambulances coming in all at once, so you have to end up with quite a lot of cards coming out. From triage point of view, it can be a



bit fiddly because you've got these bits of paper, floating round to find a card. It looks more disorganised than it is."

The nurses station in majors is also a problem *vis à vis* the projection of a professional image to third parties. The nurses station is a large desk where the activities of majors is co-ordinated by the nurse in charge. It is used for discharges and handovers, keeping records and logs (e.g. medical referrals, duty rosters, the bed state book). It is also the location of the emergency phones, and is a convenient surface which doctors use to write-up their notes and meet other professionals (e.g. the psychiatrist). In the following quote a senior sister tells quite graphically why she objects to the way the nurses station is used:

"I don't think it's a great image for frustrated patients and relatives who sort of see this collection of nurses and doctors standing there, as they see it. It looks to the outsiders as if they're all (the doctors and nurses) just huddling together having a little chitchat, and nine times out of ten we're not, the doctors are sitting writing there, we could be gathering about where to put patients or what ever ... I think it's very loud and I don't think it gives people a good impression. I mean you would never have that .... it's a bit over the top.... But if sometimes when I've been outside and you bring a patient through, a relative who's been waiting for hours and there's loads of staff just standing there, it looks awful. And yet, it doesn't give a true picture really of what's been going on. It can just give a wrong opinion of what staff are doing. I don't really think that gives the image that we're looking for. So I don't really like that".

Some nurses also worry that the use of the computer makes it look to the public as if they're not doing any work. For instance, on triage where the nursing staff play a very public role, one nurse commented:

"The bit I always fear is that people (that is patients or their relatives) come out (of the triage holding bay) asking for pans, or bed pans, or asking for a drink of water...And you look as though you're doing nothing. They must think 'what kind of nurse is she sitting there playing with her computer all day when there's people who are ill and need care?'"

Interestingly, then, the nurses want to portray themselves as caring professionals, but the logistics of dealing with so many patients (and the strategies used to do so) seem to militate against such a portrayal. Indeed, it even militates against portraying themselves as competent with regards to their co-ordination tasks.

### 3.6. Summary

In the above, we have described the categories and the concepts that emerged as salient from the data analysis, as well as how they interact with each other. We have discussed the causes of a mismatch between demand and resources, the strategies used to deal with this mismatch, the conditions under which these strategies occur, and the consequences of these strategies for the medical staff and patients involved.



This conceptualisation is not claimed to be exhaustive (as we shall see in the next section), but it is believed to reflect at least some of the subjective concerns of the staff working in this A&E department.

In sum, the conceptualisation provides an *understanding* of the requirements problem via the construction of a rich description of the organisational and social culture of the A&E department and its work practices; and provides a *specification* of requirements insofar as it offers support for the re-design of an healthcare information system.

## 4. Discussion

In this section, we shall consider the limitations of the Grounded Theory analysis presented above, and its potential benefits insofar as it may support the re-design of an healthcare information system.

### 4.1. Limitations of the Analysis

This section outlines some limitations of the analysis, by highlighting some constraints acting on the research process.

The adequacy of the research process, can be judged relative to the way in which it: generates; elaborates; and tests the developing grounded theory (Strauss and Corbin, 1990).

From the point of view of the *generation* of theory, Chapter 3 has already described how data for this study was collected. To briefly recap, three visits were made to the A&E department. The first was an orienting visit to meet the staff and have an informal look around the department. The second visit consisted primarily of an observational study, but the author took the opportunity to talk with staff as they worked whenever possible. The third visit was to conduct a number of in-depth interviews with medical staff. The author also obtained further documentation at a later date, and had further meetings with the developers.

These data collection activities are adequate, but not extensive, with respect to a grounded theory study which demands both breadth and depth of theoretical sampling (for incidents and events). The observations and informal conversations with staff were conceived to add breadth to the analysis, whilst the interviews added depth to the analysis. The study was constrained by the fact that the same data were used for this study as was used for the MUSE analysis. This constraint meant that the iteration between data collection and data analysis was compromised, since the author did not use the analysis to guide further data collection. However, given that the data that were collected were very open (in the sense of having both breadth and depth), and quite extensive the author could return to the data to sample further during coding.

From the point of view of the *elaboration* of theory, it should also be noted that this grounded theory analysis was only carried out as a component of the broader aims of this



thesis, and consequently one should not expect it to have the conceptual and theoretical density of a grounded theory study which may take a team of researchers four or more years to complete (for example, see Strauss et al, 1985). However, in the context of the aims of the thesis it is believed to be sufficient and fit for purpose for three main reasons. First, we have specified connections between the data and the conceptual abstractions, and demonstrated a good fit between the categories and the data through the use of illustrative examples. Second, we have also made explicit the categories and the concepts and data on which they are based (see Table 6.2, for instance). Third, the conceptualisation takes into account the differing conditions in triage, and the major and minor treatment areas and exhibits a density and variation that one would expect of a grounded theory study (albeit a limited one in this case).

There are essentially two ways in which the conceptualisation may be *tested*. It may be shown to be intelligible to the actors involved, and/or it may be acted upon and the success of those actions assessed (Diesing, 1972). A combination of these two approaches is obviously preferable, but was not obtainable in this study. In this case, the conceptualisation was not tested with the actors for pragmatic reasons. The *modus operandi* of the system development company (who provided access to the site) is to elicit information through interviews and meetings, and then build a prototype which can be used to elicit further information as required. The developers did not want to jeopardise this strategy (which suits them well) by adding new intermediate steps (which might set a precedent for the writing and evaluation of 'unnecessary' documentation). Given this position, the only test of this conceptualisation of the A&E department will be the extent to which it supports the re-design of the healthcare information system. The extent of such support is touched upon in the next section, and discussed in depth in Chapter 7 and Chapter 8.

## **4.2. Supporting the Re-design of an Healthcare Information System: Organisational Reality as Local Logics**

In this section, we propose that the mismatch between demand and resources (and the causes, conditions, strategies and consequences associated with this mismatch) represents an organisational reality which the information system must address (and hence be designed to address).

Anderson (1994) has stressed the importance of *local logics* that occur in particular organisational settings. These local logics represent the ways in which the actors make sense of their work practices and work communities (and are in this sense a sort of practical logic used routinely in the workplace). He also suggests that there are often multiple local logics on view in any work setting, and that design should play through the possibilities offered by such multiple local logics. Anderson also believes that designers should go with the grain of

those local logics rather than impose a more 'rational' view based on traditional 'problem-solution' interventionist design framework.

We can think of the conceptualisation of organisational reality described in this report as one form of local logic that was identified and elaborated by the author using the Grounded Theory method, and that other conceptualisations would also be possible. This viewpoint is completely in line with the ethos of the Grounded Theory method which frames and interprets the subjective reality of the actors involved whilst trying to stay as close to that subjective reality as possible. This implication of this position is that the organisation reality we have conceptualised will only inform some aspects of the re-design, and does not provide a complete context for the proposed system.

This said, the next step is to consider how this local logic can inform the re-design of an healthcare information system. This is the subject of Chapter 7.



# Chapter Seven

## Application of the Dialectic Approach to Requirements Constructed by MUSE and Grounded Theory

To want to see differently is no small discipline  
Friedrich Nietzsche (1910)

### 1. Introduction

In Chapter 3, we provided a ‘first pass’ at developing a dialectic approach which was suggested might support multidisciplinary practice by practitioner by supporting the practical accommodation of paradigms.

The dialectic approach comprised two components: a dialectic process consisting of the three key features of reflection, negative reasoning and positive reasoning; and a framework which operationalises this dialectic process (where the framework itself comprises a general conceptual model of argumentation, supported by criteria for assessing the cogency of arguments).

For convenience, the dialectic approach and its operationalisation are summarised in Table 7.0 below.

Process	Operationalised Process (instance of)	Product	Operationalised Product (instance of)
Reflection	Construct Requirements Argument using outputs of MUSE method.	Understanding	Specification of Data, Claim, and Warrant using MUSE outputs (from Statement of User Needs)
Negative Reasoning	Critique Requirements Argument using outputs of Grounded Theory method	Dialectic Comment	Specification of Rebuttals and Qualifiers using Grounded Theory method outputs (from analytic report)
Positive Reasoning	Assess Requirements Argument and Act on this Assessment	Resolution	Statement of Cogency of Requirements Argument and Planned Actions

Table 7.0: Dialectic Processes, Products and their Operationalisation

This chapter applies the operationalisation of the dialectic approach in the re-design of an A&E healthcare information system for a major UK hospital. This application illustrates how the dialectic approach can support multidisciplinary practice by practitioner by

supporting the practical accommodation of two different paradigms (i.e. post-positivism and constructivism). Specifically, we apply the operationalisation to the requirements generated by the MUSE method (as represented in the Statement of User Needs, see Chapter 5) and the Grounded Theory method (as represented in the analytic report, see Chapter 6). This application is assessed in Chapter 8.

## **2. Application of the Operationalisation**

In the application of the operationalisation, we take the following steps:

- 1) A requirements argument (RA) is constructed using the outputs of the MUSE method as identified in the Statement of User Needs (SUN - see Chapter 5).
- 2) The requirements argument is critiqued using the outputs of the Grounded Theory method as identified in the Analytic Report (see Chapter 6).
- 3) The cogency of the RA is assessed using the criteria proposed in Chapter 3. That is, the second part of the framework for argumentation is applied.

The following sections address each requirement from the SUN in turn.

### **2.1. SUN Requirement #1**

This section follows the three steps outlined above with respect to the first requirement in the SUN, which stated that:

The system should obviate the need for triage nurses to create hand-written triage information. That is, triage information should be recorded solely in electronic form.

#### **2.1.1. Construct Requirements Argument (RA)**

Using the MUSE analysis reported in Chapter 4, a Requirements Argument (RA) for SUN Requirement #1 was constructed, and its data, warrant and claim specified, as shown in Figure 7.0:



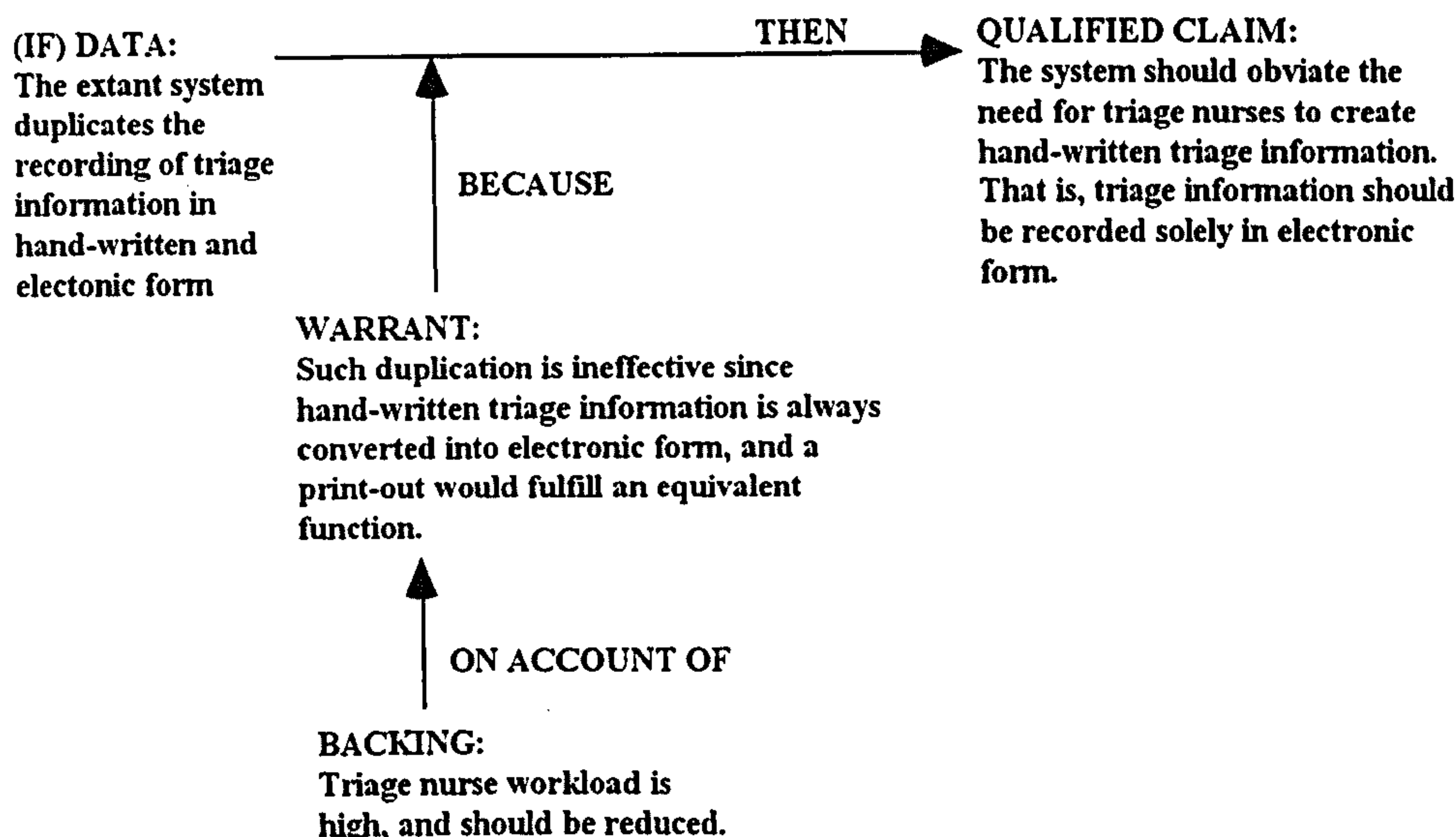


Figure 7.0: Specification of the RA for Requirement #1

## 2.1.2. Critique Requirements Argument (RA)

Figure 7.1 critiques the RA using information extracted from the Grounded Theory method reported in Chapter 5 (Sections 3.3.1.2 and 3.3.2.2).

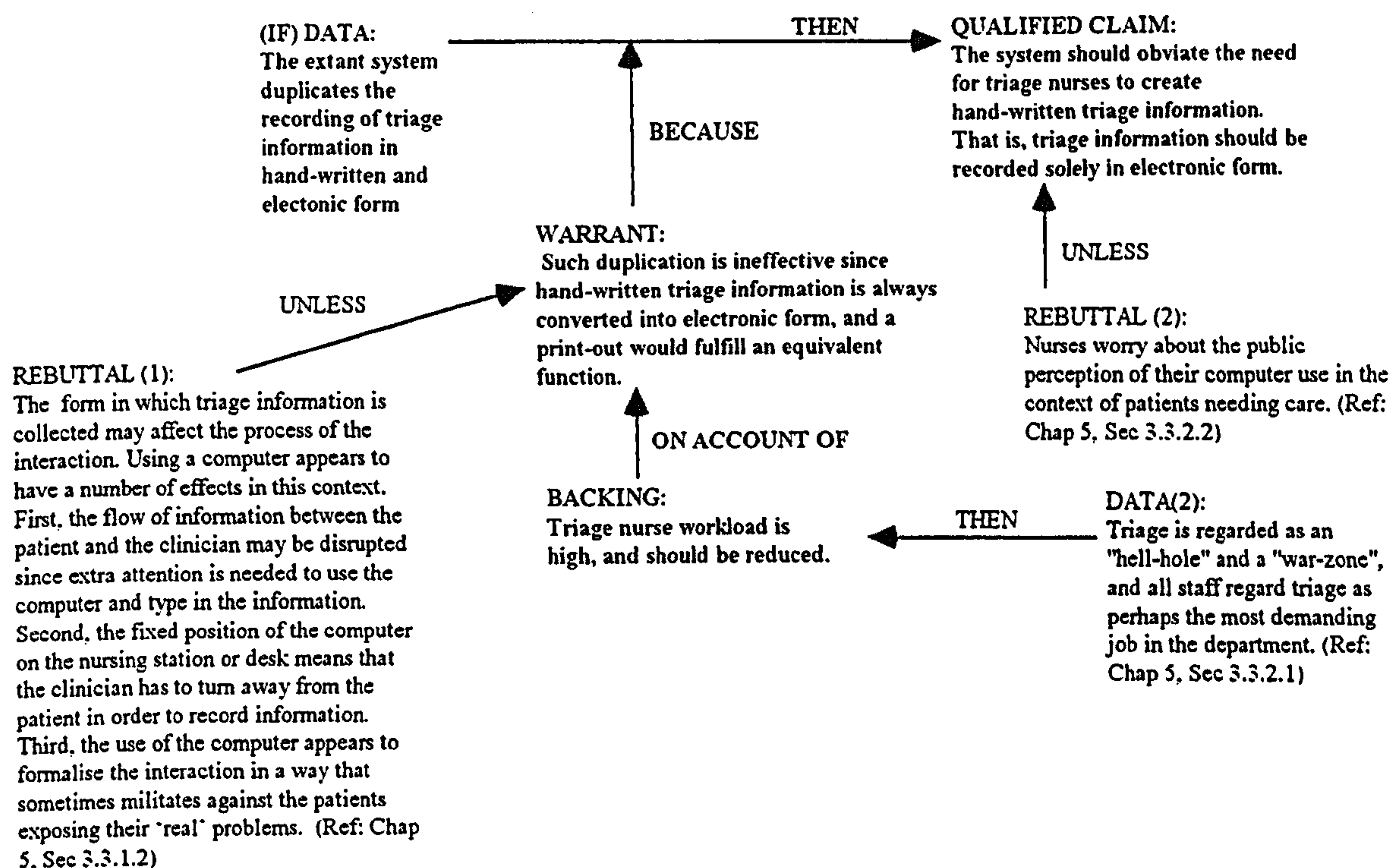


Figure 7.1: Critique of the RA for Requirement #1

The warrant argues that the duplication of triage information is ineffective, since it requires a costly conversion of hand-written data to electronic data. Ineffectiveness is a concept that is often used within human factors (HF) to suggest that a work is either not performed to the desired level of quality, or uses too many resources in its achievement. Rebuttal (1) questions the suitability of this concept in this instance, and proposes instead that we should not focus solely on the task of recording *per se*, but the human-human social interaction upon which such recording is predicated. That is, the rebuttal highlights a conceptual difference (i.e. between task ineffectiveness in recording information, and the importance of factors influencing human-human communication) that may be pertinent in this instance. Also, rebuttal (2) attacks the claim by arguing that nurses worry about the public perception of their computer use in the context of patients needing care.

The backing argues that the workload of triage nurses is high and should be reduced. Again, this is a concept familiar in HF which is embedded in the argument. In this instance, however, this concept appears to be concomitant with the more subjective notion that triage is a “hell-hole” or a “war-zone” so conceptual difficulties are insignificant here. Instead, assuming an informal equivalence of terms, we may draw on this additional data to support the notion that triage nurses have a high workload (and that this workload should indeed be reduced).

### 2.1.3. Assessment of Cogency

As described in Chapter 3, assessing the cogency of a RA involves assessing the *legitimacy* and *plausibility* of that argument in the light of the rebuttals. In the following, underlined words refer to criteria used in assessing legitimacy and plausibility that were introduced in Chapter 3.

The data (1) and the backing of this RA are fairly self-evident, and appear to meet the criterion of certainty. However, we do not have good reason to believe in the warrant as it stands, since rebuttal (1) suggests that the concepts it uses may be misplaced. For these reasons, the grounds for the argument are not deemed to be acceptable, and, therefore, do not appear to be *legitimate*.

Given the significant attack on the warrant, the grounds are only weakly relevant to the claim, and additionally in the light of rebuttal (2) do not provide sufficient reasons to make it rational to accept the claim. In this respect, then, the RA is not deemed to be *plausible*.

Figure 7.2 shows the assessment of this RA after rating its legitimacy and plausibility.



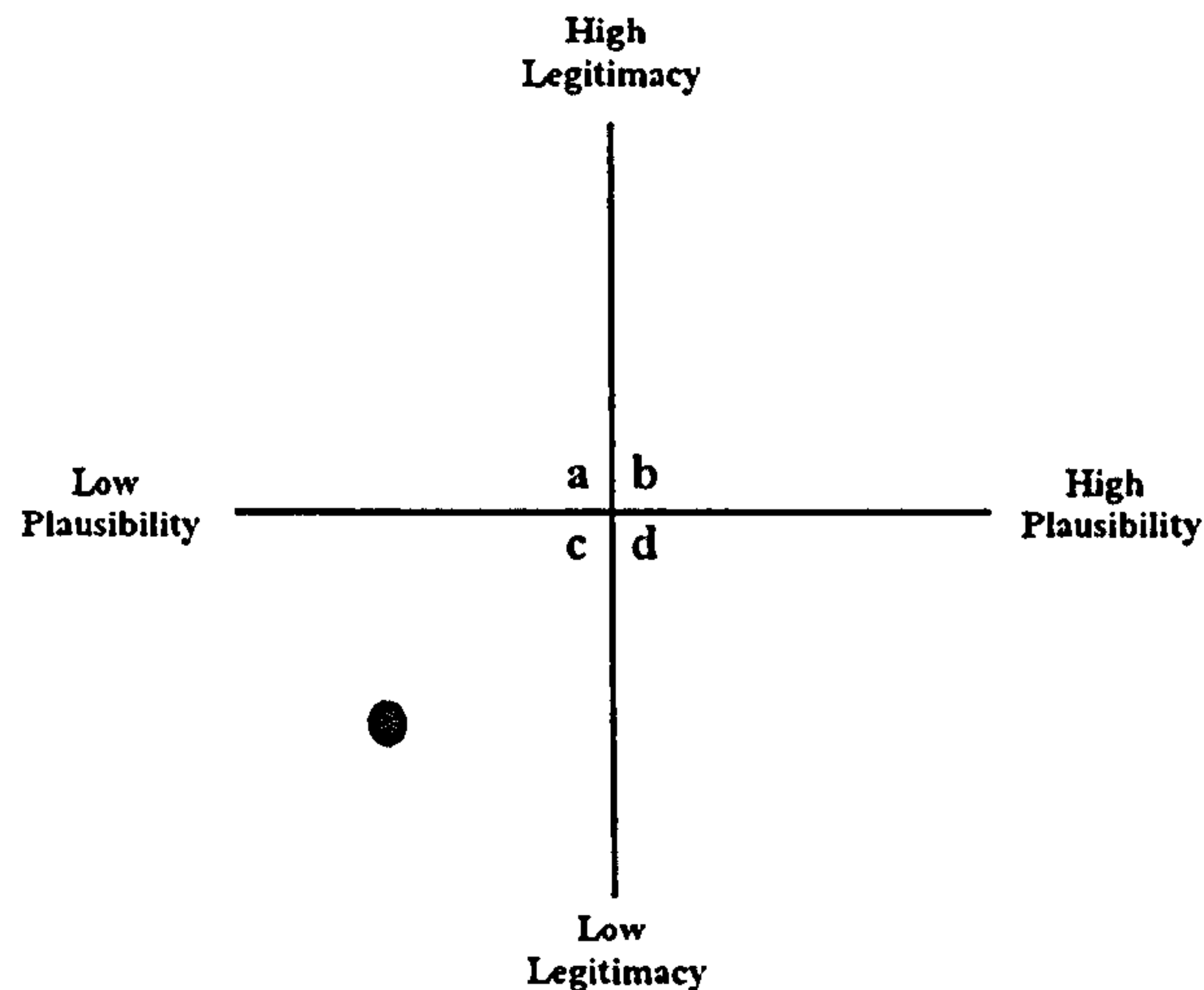


Figure 7.2: Assessment of the Cogency of the RA for Requirement #1

The RA is judged to be in Quadrant c) which means that we should either: reject the original argument, and replace it with a counter argument constructed from the rebuttals; or look for a synthesis of elements of the argument leading to a resolution of their opposition and the construction of a new more encompassing argument.

In this case, an alternative argument with an opposite claim (e.g. that triage information should only be recorded by hand) would be rejected in much the same way as the original argument (since triage information must be converted to electronic form). What is required, then, is a creative resolution of the opposing views. In this case, such a resolution may be possible. For example, neither of the perspectives argues about the fact that triage nurses have too high a workload. Given this agreement, the main issue then becomes how to reduce that workload. Also, neither perspective would argue that taking away some tasks from the triage nurses would reduce that workload. In this instance, a resolution might consist of arguing that triage nurses should record triage data by hand, and that responsibility for the electronic recording should be re-allocated to another class of member of the A&E staff (perhaps administrative staff such as clerks, for example. {N.B. Many administrative staff are trained to understand and interpret clinical language}). This resolution is represented for completeness in Figure 7.3.

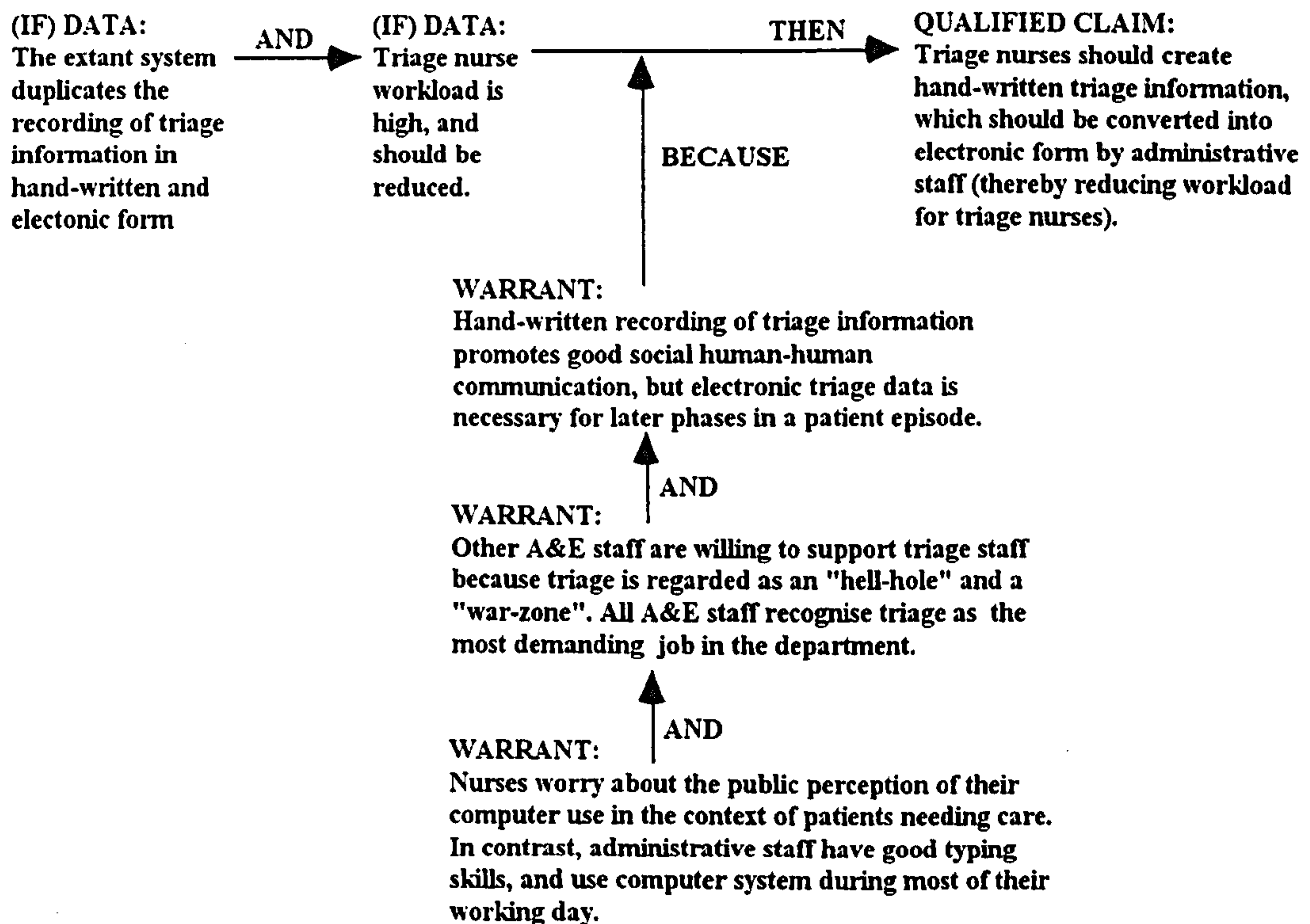


Figure 7.3: Resolution of Opposing Views w.r.t. Requirement #1

Seeking a resolution of the opposing points of view was predicated, in this instance, on identifying points of agreement, and using such agreements to construct a new argument. The construction used the notion of transposing argument elements. For example, the backing of the original RA was used as data in the resolution.

## 2.2. SUN Requirement #2

This section follows the three steps outlined above with respect to the second requirement in the SUN, which stated that:

2. Triage information pertaining to a patient episode must be made available in a physical representation once a patient is admitted to a treatment area.

### 2.2.1. Construct Requirements Argument (RA)

Using the MUSE analysis reported in Chapter 4, a Requirements Argument (RA) for SUN Requirement #2 was constructed, and its data, warrant and claim specified, as shown in Figure 7.4:



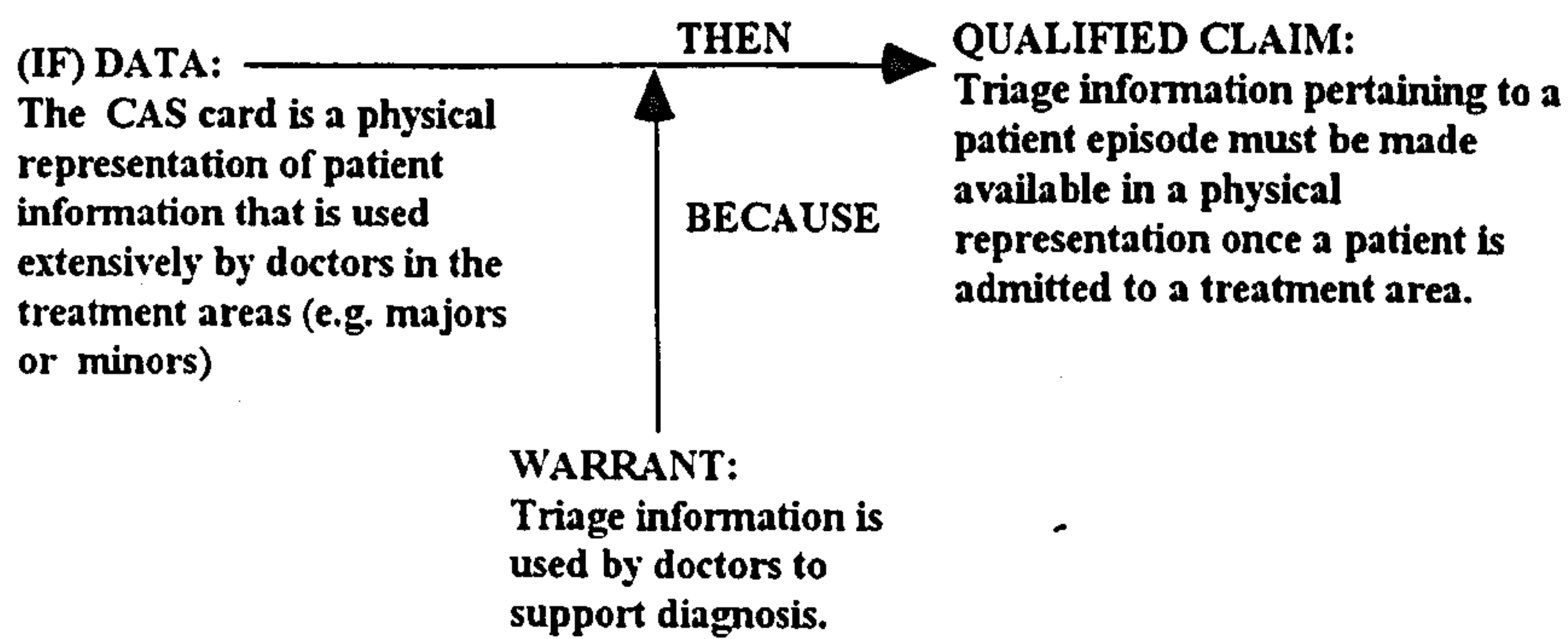


Figure 7.4: Specification of the RA for Requirement #2

### 2.2.2. Critique Requirements Argument (RA)

Figure 7.5 critiques the RA using information extracted from the Grounded Theory method reported in Chapter 5 (Section 3.4.1).

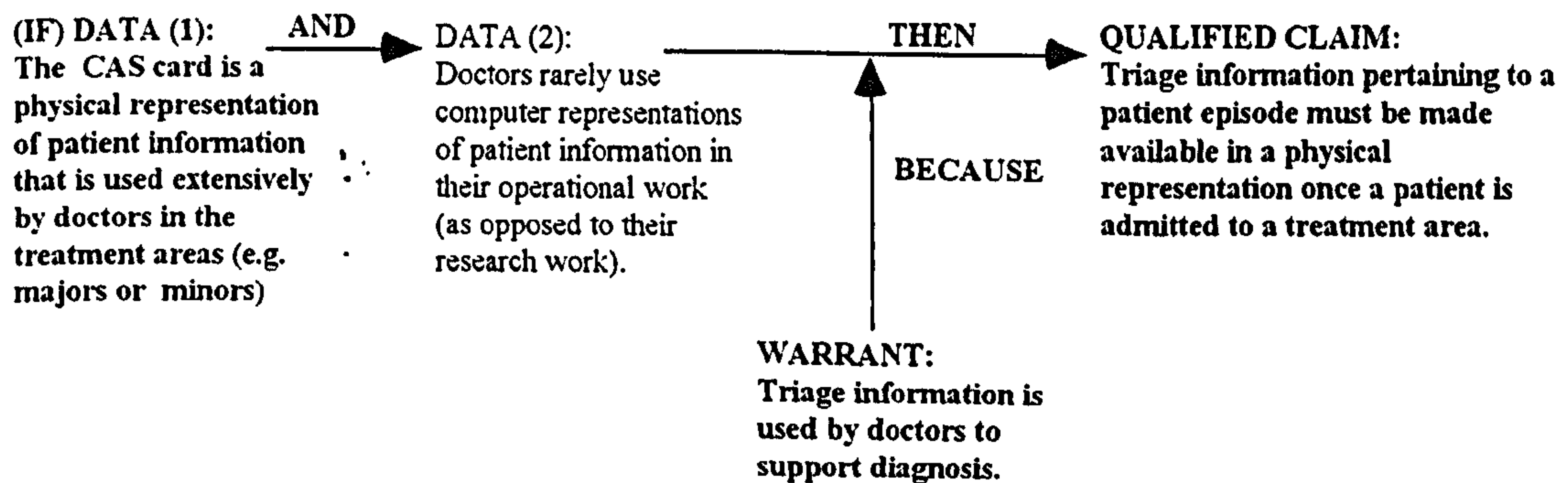


Figure 7.5: Re-expression of the RA for SUN Requirement #2

At first glance, it seems evident that this requirement should be accepted. That is, it would appear that there is little information from the Grounded Theory method that is relevant to the requirement, and the claim seems to be uncontended. In the next section, however, a detailed assessment of the cogency of the requirement will expose an important issue with respect to the dialectic process.

### 2.2.3. Assessment of Cogency

The grounds of the RA appear to be *legitimate*. That is, we can be reasonably certain that the data and the warrant are correct, and that they are consistent and coherent.

However, when we assess the *plausibility* of the RA, we can see that the claim does not exist in isolation from other requirements. Indeed, it is clearly linked to the original expression of Requirement #1 (that the system should obviate the need for hand-written triage information). That is, the claim was originally consistent with other requirements, but these requirements have since been amended. These amendments may mean that the

requirement is now itself inconsistent with those revised requirements, and we need to check for the influence of any such changes on this requirement.

For example, the claim of this RA is predicated on the notion that up to this point in a patient episode, triage information is only represented in electronic form (since triage nurses will only record triage information electronically). This predicate has not changed in this instance, since although the amendment to Requirement #1 has proposed that triage nurses collect triage information in hand-written form, the electronic version that is prepared by other A&E staff is still the only representation of triage data that is to be communicated to the treatment areas. The claim, then, remains essentially true, insofar as although the doctors might be given the hand-written notes, the amended version of Requirement #1 suggests that a CAS card should be printed to include all current information (including patient basic data and triage information). In this instance, there is no need to represent the influence of amendments to previous requirements on the current RA, however, in other instances it may be important to characterise such influences, and specify their relationships to the RA in terms of new or existing argument elements (see analysis of Requirement #3).

Figure 7.6 shows the assessment of this RA after rating its legitimacy and plausibility.

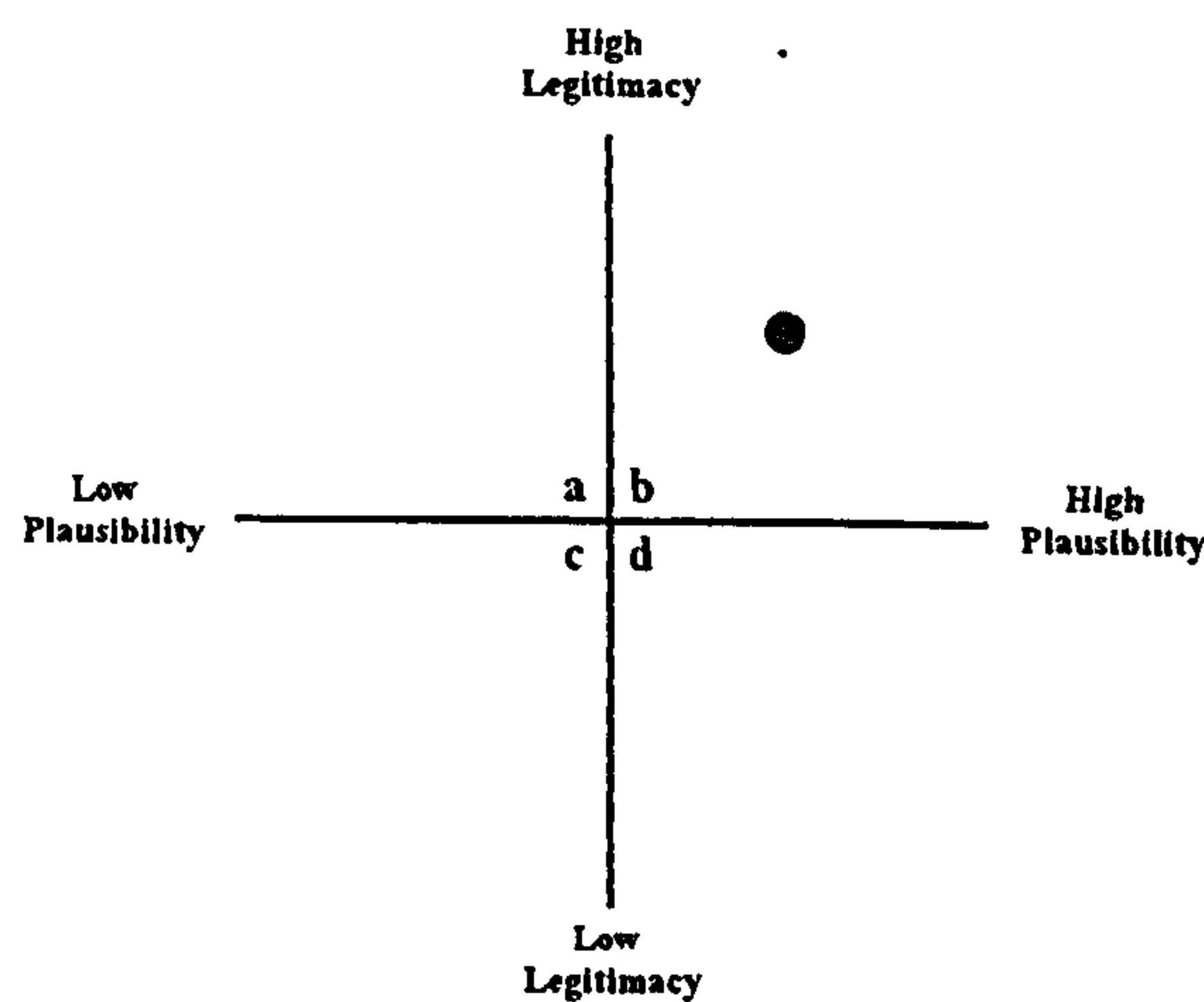


Figure 7.6: Assessment of the Cogency of the RA for Requirement #2

The RA is judged to be in Quadrant b) which means that we should accept this requirement in its current form.

### 2.3. SUN Requirement #3

This section follows the three steps outlined above with respect to the third requirement in the SUN, which stated that:

- 3. The system should minimise the time taken by triage nurses to input triage data to the electronic patient record (performance improvements may be assessed with respect to current input times).



### 2.3.1. Construct Requirements Argument (RA)

A Requirements Argument (RA) for Requirement #3 is expressed in Figure 7.7:

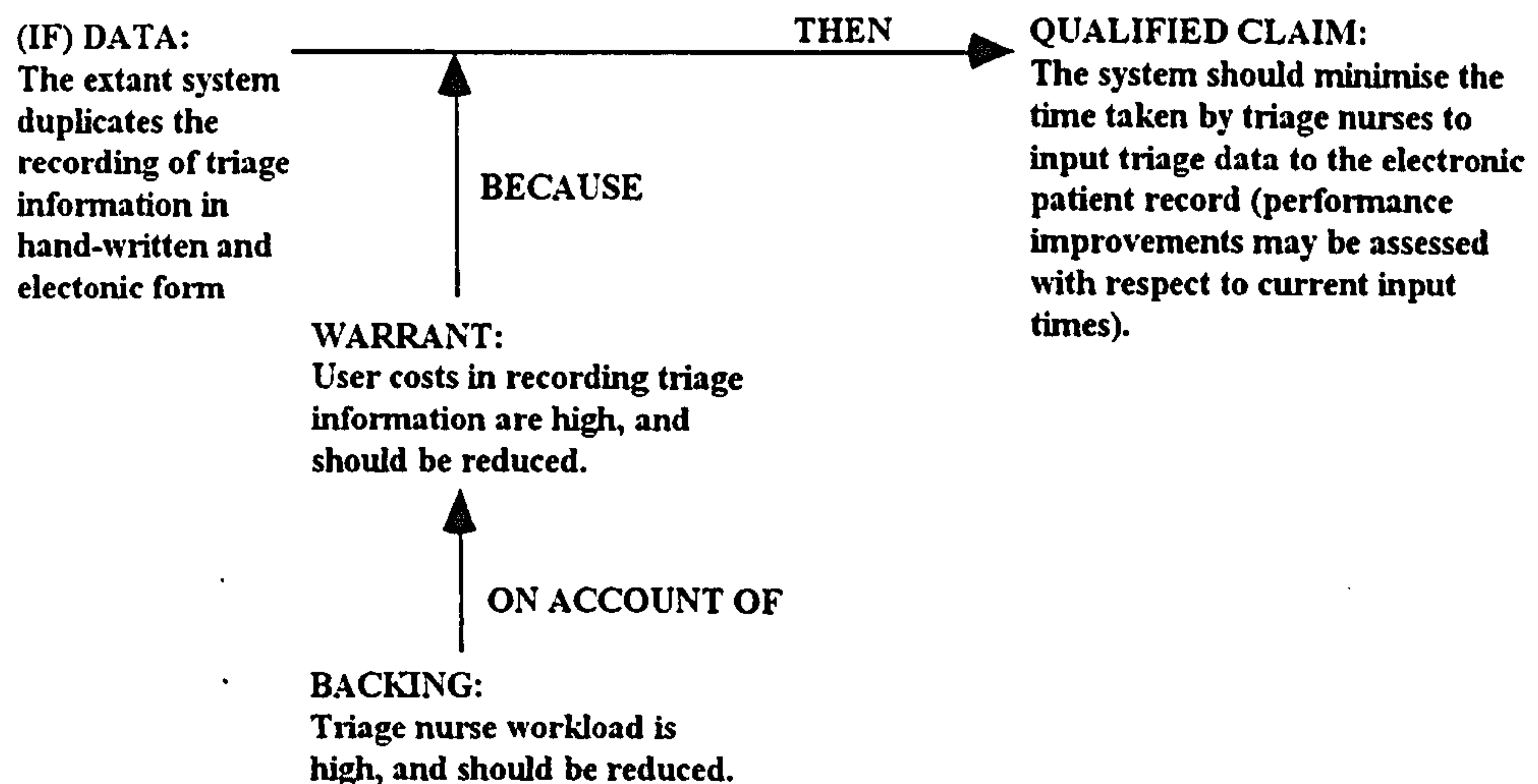


Figure 7.7: Specification of the RA for Requirement #3

Again, this requirement is clearly linked to Requirement #1, which has itself been amended. We need, therefore, to examine this requirement in the light of the new Requirement #1. The new Requirement #1 has suggested that input of triage data to the electronic patient record should be performed by an administrative member of the A&E staff.

Administrative staff are experienced in the use of the computer system and are highly skilled typists, and therefore, we might expect their performance on data input tasks to be better than that of the triage nurses (who typically are not so computer literate or such skilled typists). New performance times cannot, therefore, be assessed relative to the performance of triage nurses; though, as a general rule we might safely assume that the requirement could still usefully be applied to the support provided to the administrative staff.

Figure 7.8 shows how the requirement might be modified to propose that instead the system should minimise the time taken for administrative staff to input triage data to the computer system.

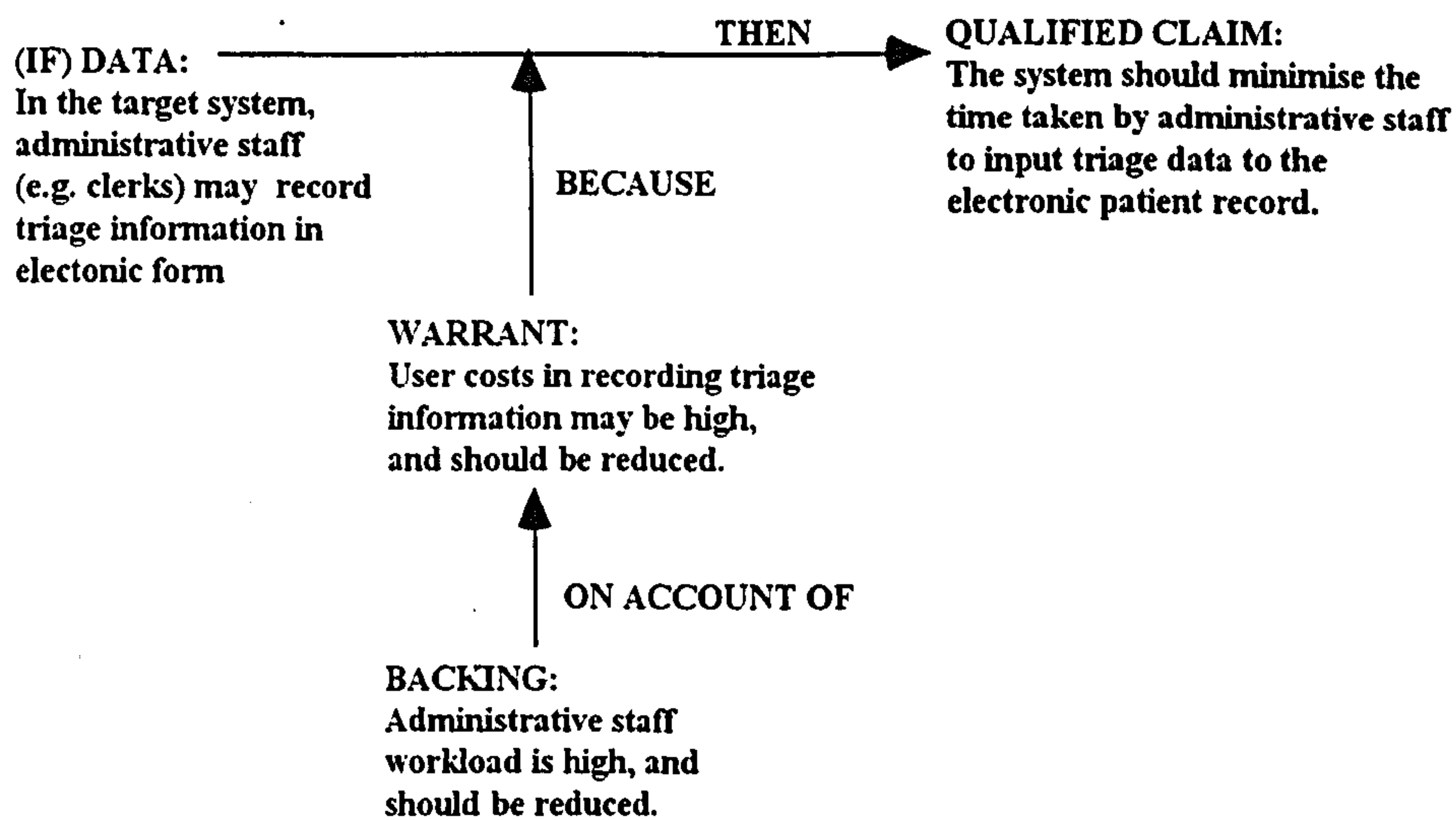


Figure 7.8: Modification of the RA for Requirement #3

### 2.3.2. Assessment of Cogency

In general, the grounds for an RA should be more certain than its conclusion. However, in this case, we cannot be certain of the grounds, since they are a speculative extrapolation from the original grounds. In their current state, then, we cannot accept them as *legitimate*. However, reasoning by analogy, we might believe that the grounds taken together are sufficient for us to find the claim *plausible*.

Figure 7.9 shows the assessment of this RA after rating its legitimacy and plausibility.

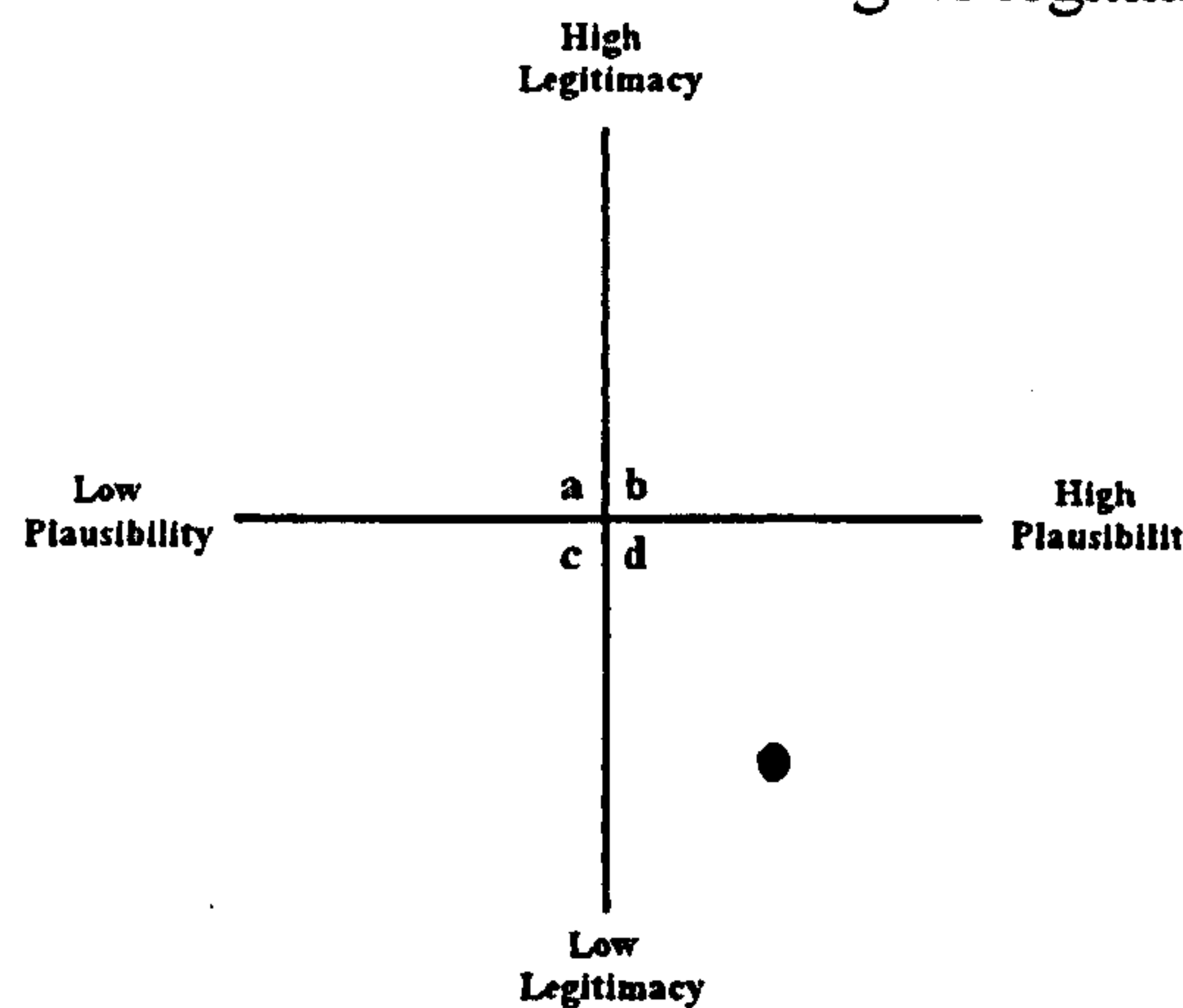


Figure 7.9: Assessment of the Cogency of the RA for Requirement #3

The RA is judged to be in Quadrant d) which means that we should conduct further research to improve the grounds of this requirement (i.e. to ascertain whether the workload of administrative staff is indeed too high). Unfortunately, this research is not practicable at time of writing (but could have been carried out in principle).



## 2.4. SUN Requirement #4

This section follows the three steps outlined above with respect to the fourth requirement in the SUN, which stated that:

- 4) The system should automatically calculate and record triage times.

### 2.4.1. Construct Requirements Argument (RA)

A Requirements Argument (RA) for Requirement #4 is expressed in Figure 7.10:

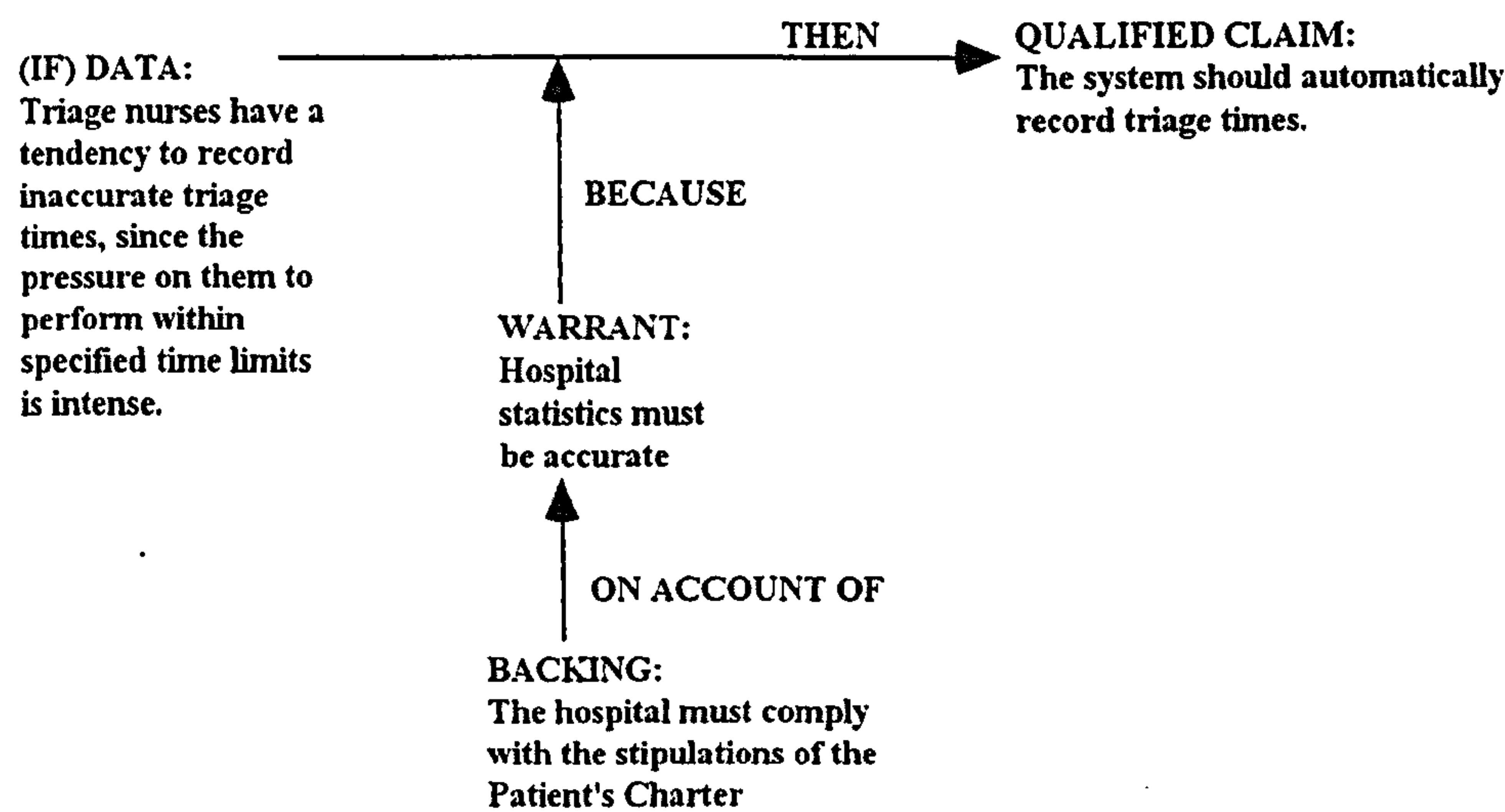


Figure 7.10: Expression of SUN Requirement #4

As suggested in Section 2.2.3 above, we should first examine this requirement for any links. Again this RA is linked to Requirement #1 which has been amended such that triage nurses no longer input data to the computer system. Under these conditions, it is no longer practicable for the computer system to calculate triage times, since triage times will have been specified by hand. The consequences of this amendment, then, is to render the claim invalid. At this point, we might simply reject this requirement. However, the data still describe a potential problem for the A&E worksystem, and instead, it may be pertinent to see if the Grounded Theory Analysis can contribute to an understanding of this problem.

### 2.4.2. Critique Requirements Argument (RA)

Figure 7.11 critiques the RA after using information extracted from the Grounded Theory method reported in Chapter 5 (Sections 3.3. and 3.5).

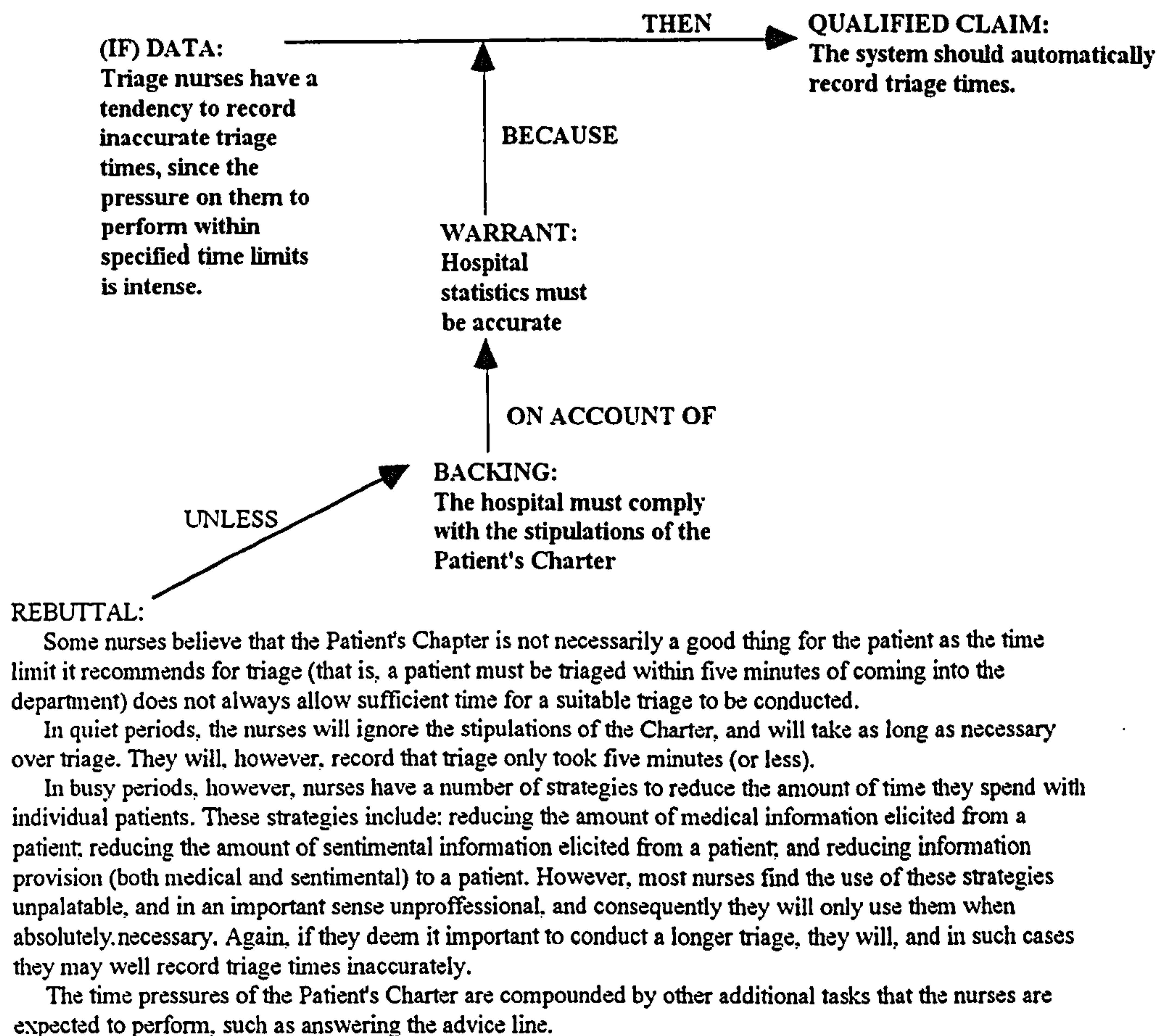


Figure 7.11: Re-Expression of the RA for SUN Requirement #4

### 2.4.3. Assessment of Cogency

With respect to the *legitimacy* of the RA, we note that we have no reason not to accept the data (especially since the rebuttal has provided us with good reason why the data are true). We are similarly certain of the backing and the warrant. Taken together, then the grounds seem to be legitimate (at least initially).

As for the plausibility of the claim, the data, warrant and backing are clearly relevant and sufficient to render the claim plausible. However, after consideration of the link to the amended Requirement #1, the claim is no longer practicable (that is, it makes no sense to continue with this requirement, if triage nurses will not be inputting data to the computer system). For this reason, the plausibility of the claim is negated. Figure 7.12 shows the assessment of this RA after rating its legitimacy and plausibility.



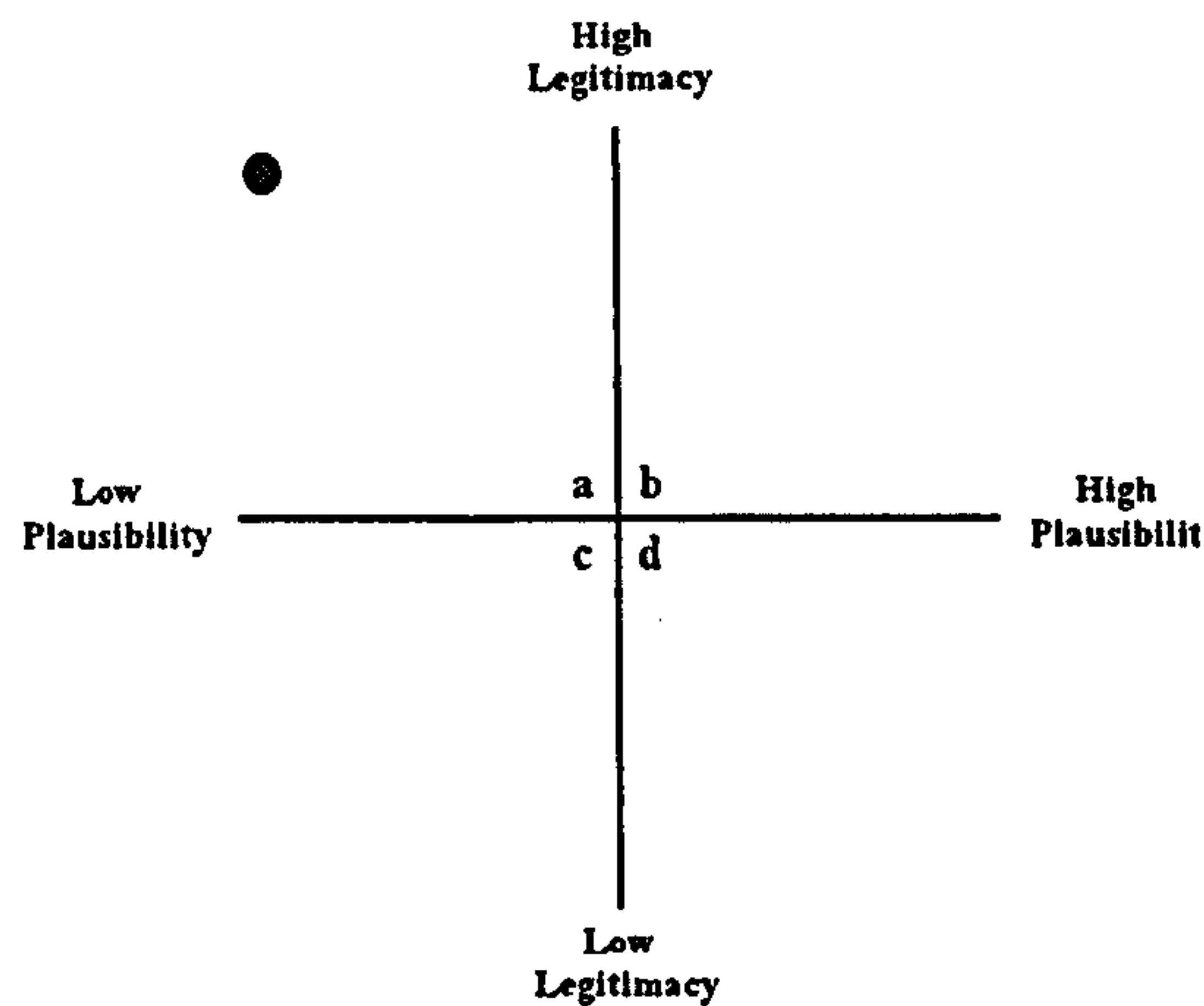


Figure 7.12: Assessment of the Cogency of the RA for Requirement #4

The RA is judged to be in Quadrant a) which means that we should conduct further research to improve the claim of this requirement.

In one sense, improving the claim in this instance might be taken to mean making the claim more general. For example, we might re-phrase the claim to propose that “triage nurses should record triage times accurately.” Alternatively, we might propose a new requirement based on our improved problem understanding. Figure 7.13 proposes such a requirement.

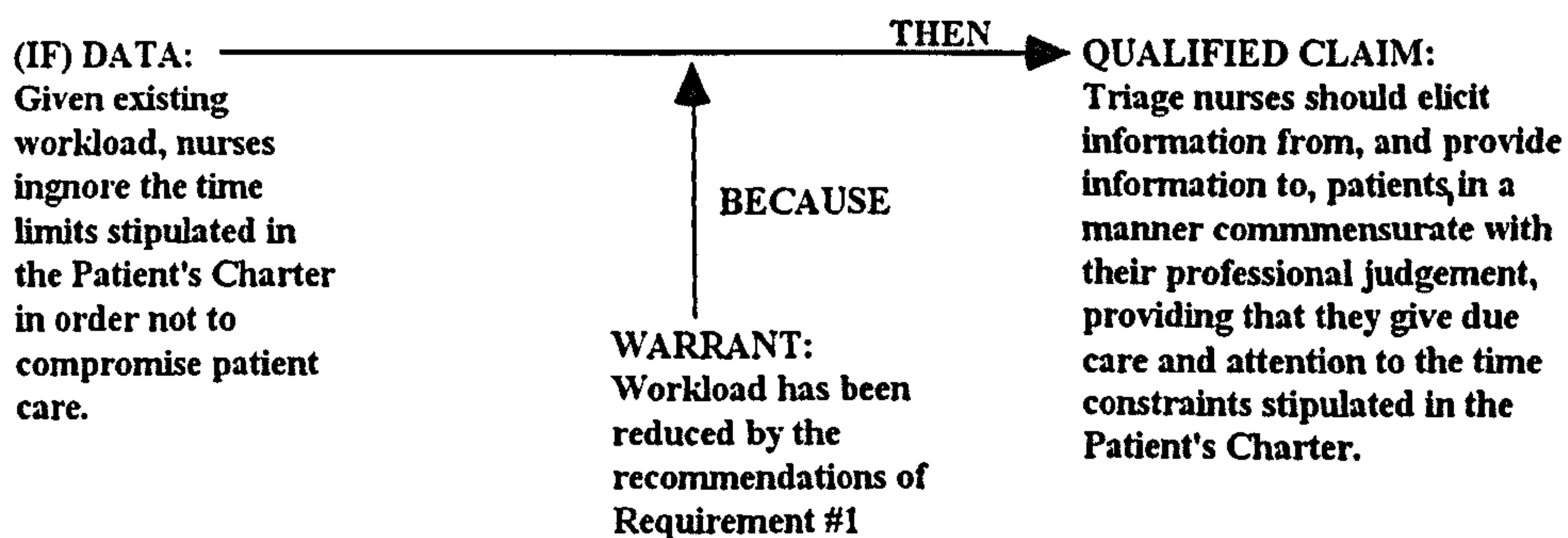


Figure 7.13: Reformulation of the RA for Requirement #4

Note that the amended Requirement #1 may support the achievement of this requirement, since it has already recommended that triage nurses be exempted from the need to record triage information on the electronic patient record.

In the above assessment, we have highlighted that sometimes it may not be appropriate to improve the claim (or indeed the grounds) of a requirements argument, but instead we should formulate a new requirement altogether. This requirement may be a synthesis of the requirements argument and its rebuttal, or it may be an entirely new argument (constructed from either method).

Seeking a resolution of the opposing points of view was predicated, in this instance, on reformulating the requirement around the rebuttal, but identifying a further qualifier to the claim.

## 2.5. SUN Requirement #5

This section follows the three steps outlined above with respect to the fifth requirement in the SUN, which stated that:

5. The system should include computer-based clinical thesauri to support the rapid formulation of standardised problem descriptions by triage nurses.

### 2.5.1. Construct Requirements Argument (RA)

A Requirements Argument (RA) for Requirement #5 is expressed in Figure 7.14:

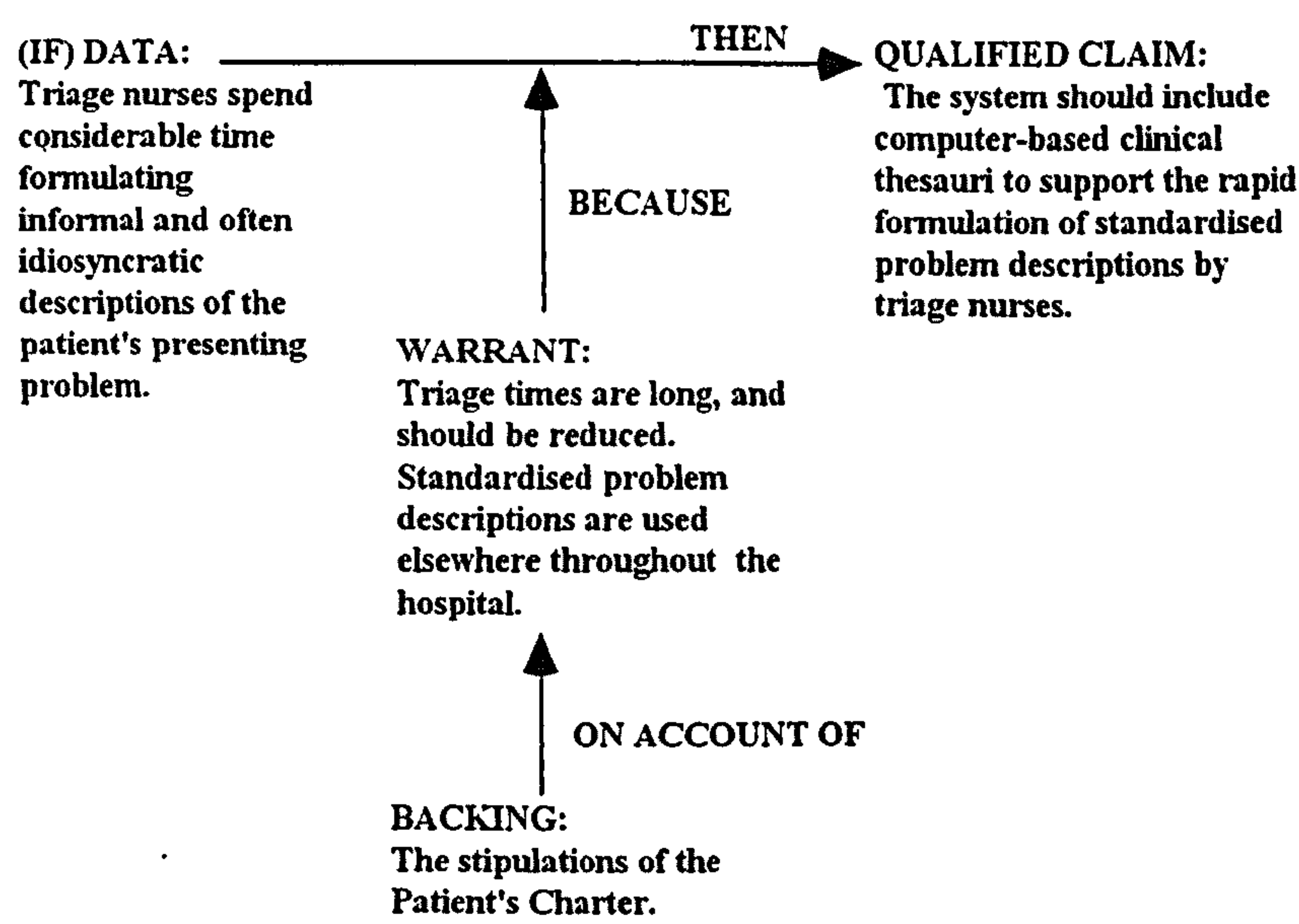


Figure 7.14: Specification of the RA for Requirement #5

### 2.5.2. Critique Requirements Argument (RA)

Figure 7.15 critiques this requirement using information extracted from the Grounded Theory method reported in Chapter 5 (Section 3.3.1.2 and 3.3.1.3).



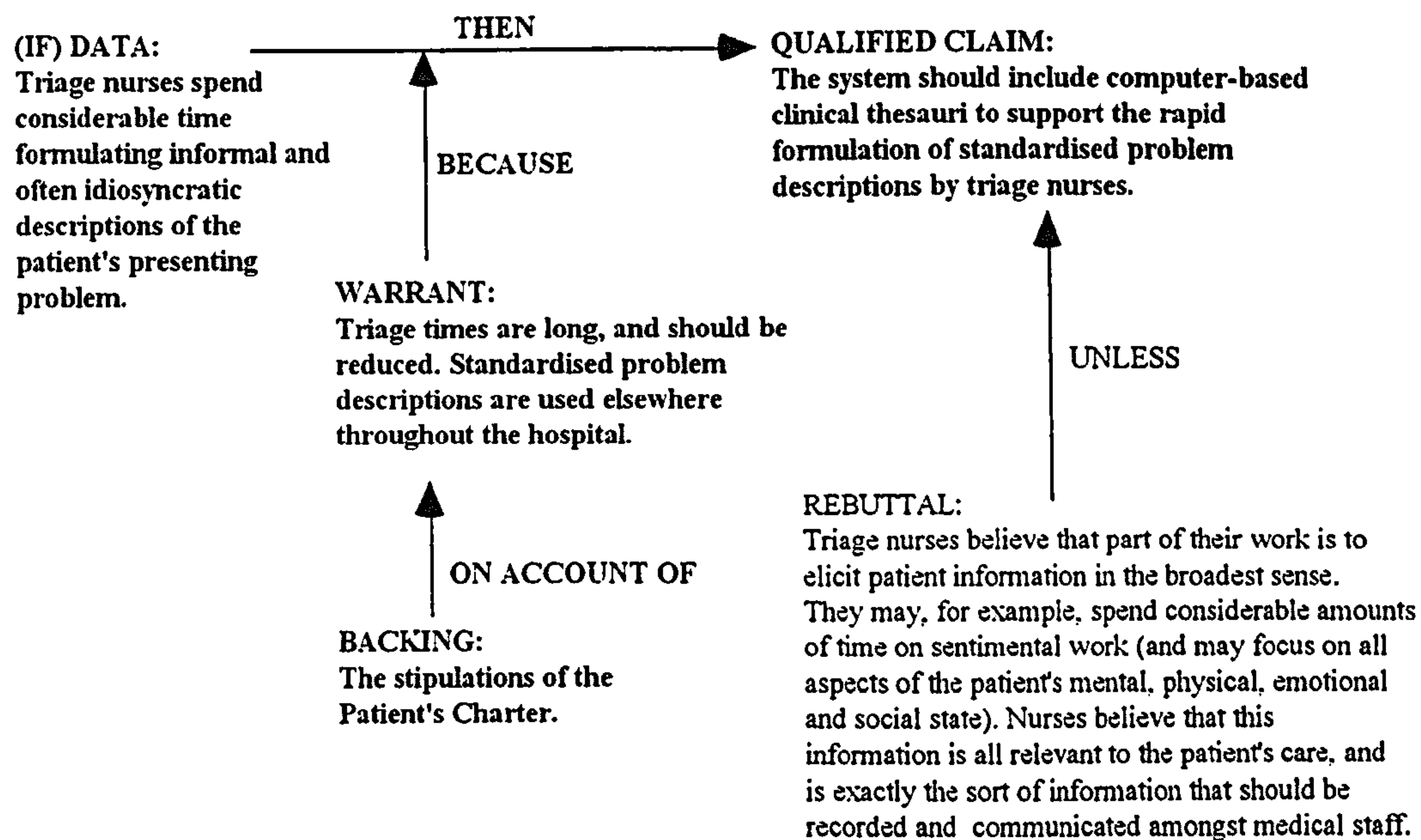


Figure 7.15: Critique of the RA for Requirement #5

The original argument concerns the effectiveness with which a triage problem description is formulated, and the data suggest that it is the informal and idiosyncratic nature of the problem descriptions that is the source of the ineffectiveness. However, from the nurses' point of view, this is precisely the sort of information that is missed in the normal course of a purely medical assessment (by doctors, say), and yet has a major impact on the quality of care for the patient. For example, whilst a purely medical description of an injury sustained by a drunk might be "concussion", a more typical problem description prepared by a nurse might be "concussion, acute alcohol problem over last month since patient's mother recently died". Broadly speaking, then, we can see that the HF analysis emphasises objective *values* concerning system effectiveness, whilst the sociological analysis emphasises the subjective values of the participants about the nature of the work that they do.

The data argue that triage nurses spend a considerable amount of time formulating descriptions of the patient's presenting problems, and implies that this contributes to long triage times for patients, and may also be ineffective insofar as they may be idiosyncratic. The rebuttal asserts that the triage nurses are actually trying to capture all factors relevant to the patient's overall state, rather than just specifying their medical condition. This explanation carries with it the assumption that medical information alone is insufficient to support good patient care.

### 2.5.3. Assessment of Cogency

In this case, whilst the grounds for the RA are consistent, coherent and explicit in and of themselves, we do not have good reason to accept the requirement as it stands, since the

grounds seem to offer a questionable interpretation of the reality of the workplace. In this sense, then, the grounds do not appear to be *legitimate*.

Similarly, although the grounds are relevant to the claim, and indeed sufficient to support it, if one accepts their underlying logic, it would appear that the rebuttal is so strong here as to seriously question the *plausibility* of the claim in a the current context.

Figure 7.16 shows the assessment of this RA after rating its legitimacy and plausibility.

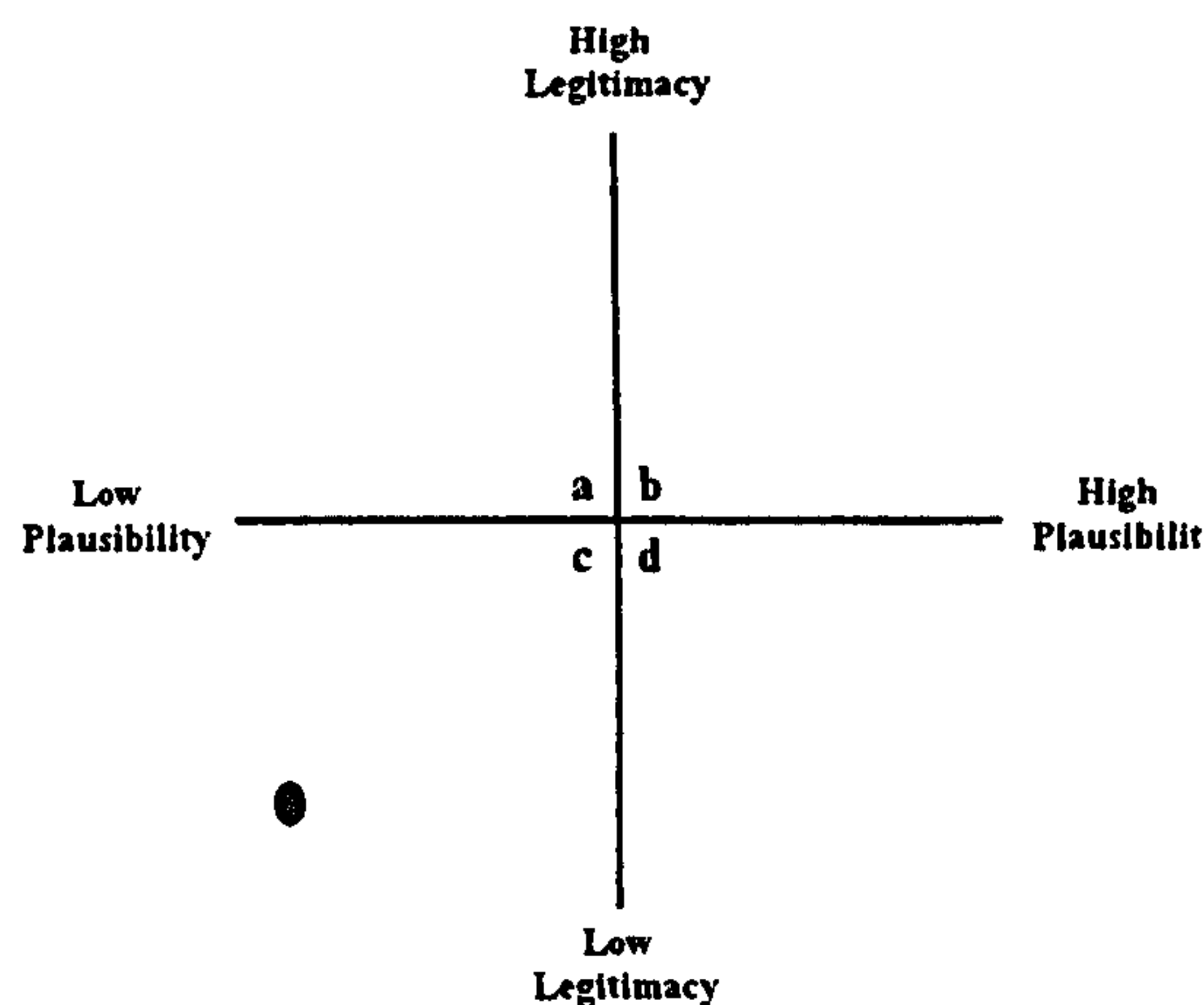


Figure 7.16: Assessment of the Cogency of the RA for Requirement #5

The RA is judged to be in Quadrant c) which means that we should either: reject the original argument, and replace it with a counter argument constructed from the rebuttals; or look for a synthesis of elements of the argument leading to a resolution of their opposition and the construction of a new more encompassing argument.

In this case, however, we are somewhat in the horns of a dilemma. First, an alternative argument with an opposite claim (e.g. that triage nurses should elicit and record as much information about the patient as they regard as necessary) would be likely to be rejected, since clearly the Patient’s Charter is a legal statute which specifies quite rigorous time limits for triage (that would be most likely to be exceeded under those conditions). Second, although we might seek a resolution which would support the use of computer-based tools with suitable extensions for additional information as required, we have suggested in the final version of Requirement #1 that triage nurses should record triage information by hand, thereby precluding computer-based support of the type envisaged (at least without duplicating elements of the task). Another kind of resolution is, therefore, required. One such resolution would be to anticipate that the reduction in workload resulting from Requirement #1 would be sufficient to allow triage nurses to adopt their preferred style, whilst qualifying the claim. This resolution is represented for completeness in Figure 7.17.



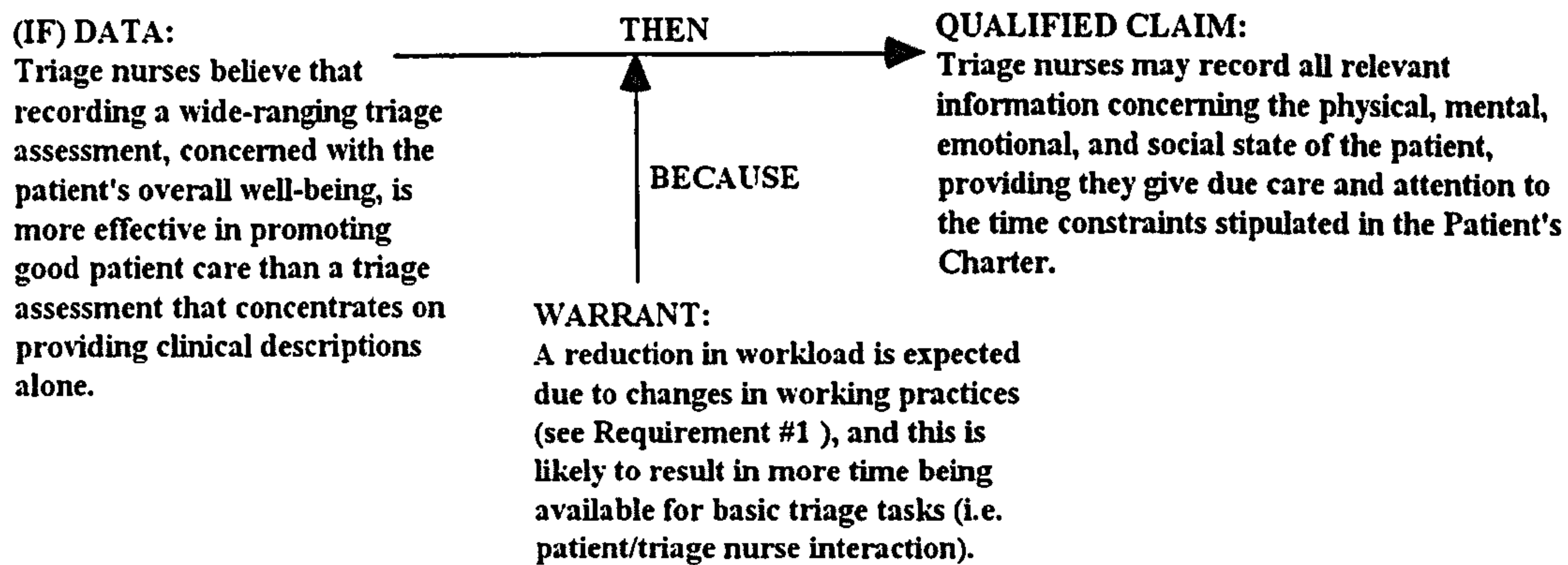


Figure 7.17: Resolution of Opposing Views w.r.t. Requirement #5

Again, seeking a resolution of the opposing points of view was predicated, in this instance, on reformulating the requirement around the rebuttal, but qualifying the claim.

## 2.6. SUN Requirement #6

This section follows the three steps outlined above with respect to the sixth requirement in the SUN, which stated that:

6. The system should provide continually up-dated collated triage information for all patients currently waiting for admittance to a treatment area in a single computer representation. Collated triage data should comprise a patient list and complete triage records for each patient. It should be possible to specify this computer representation as the default representation for selected individual machines.

### 2.6.1. Construct Requirements Argument (RA)

A Requirements Argument (RA) for Requirement #6 is expressed in Figure 7.18:

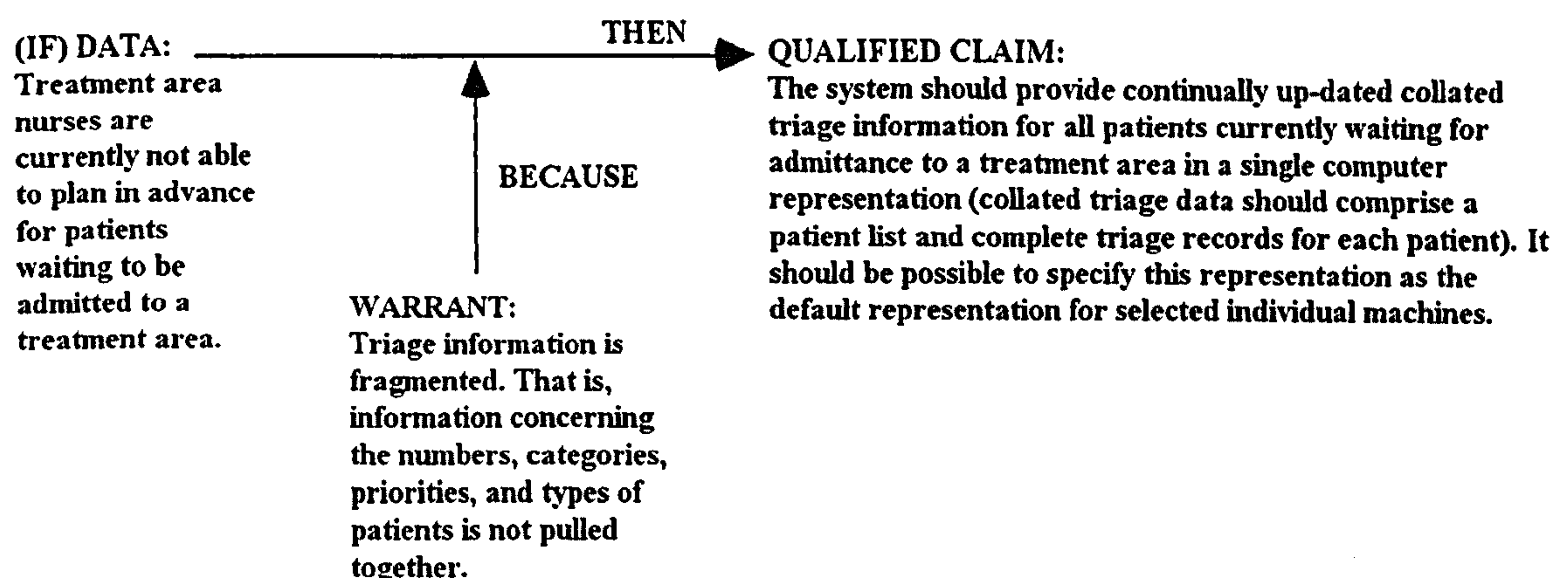


Figure 7.18: Specification of RA for Requirement #6

2.6.2. Critique Requirements Argument (RA)

Figure 7.19 critiques this requirement using information extracted from the Grounded Theory method reported in Chapter 5 (Sections 3.5.1 and 3.5.5).

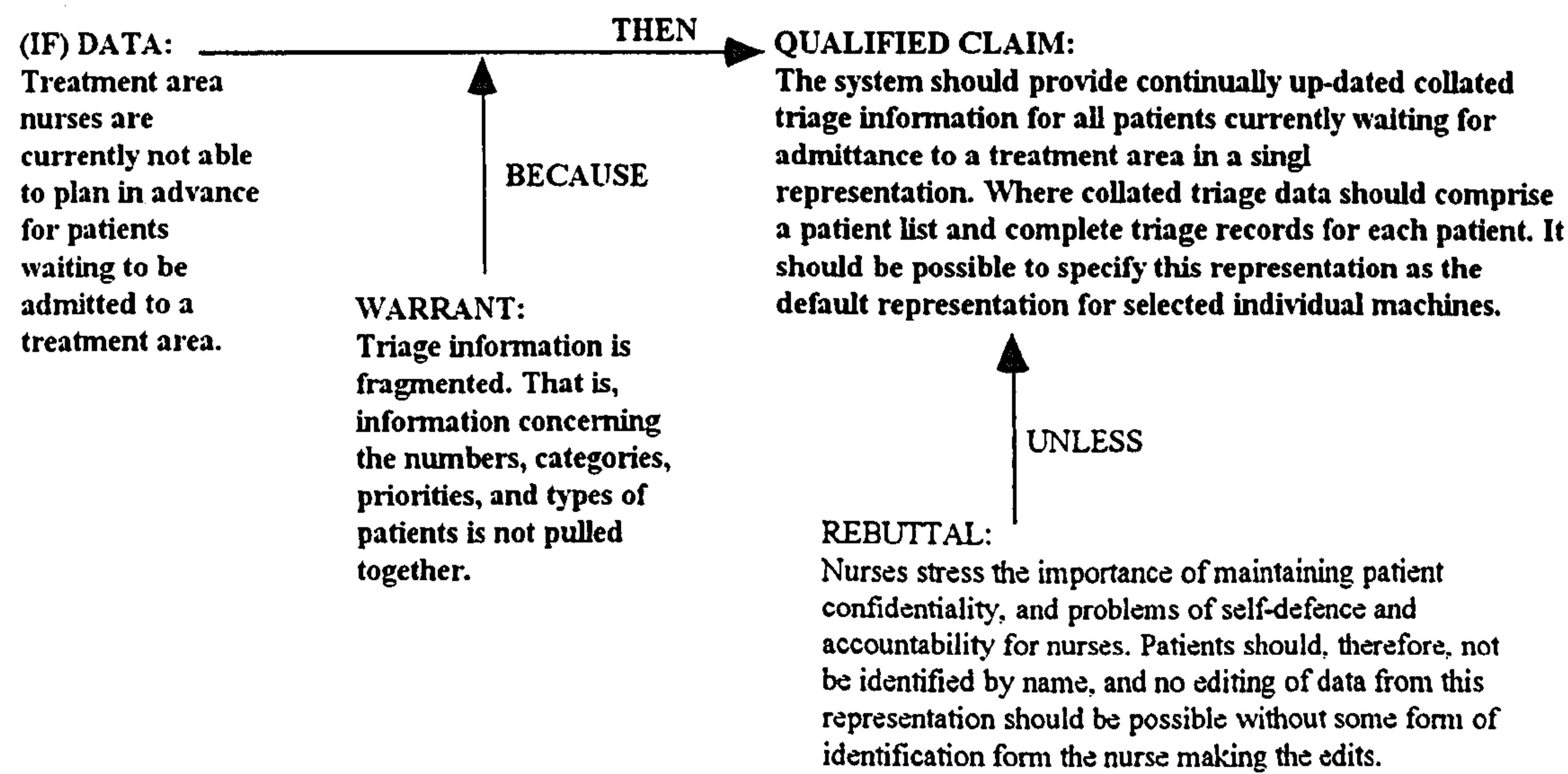


Figure 7.19: Re-Expression of the RA for SUN Requirement #6

The most important point to note in the above analysis is that the rebuttal does not indicate the conditions under which the claim does not hold, but offers a critique of one aspect of the claim (that is, that patients should not be represented by name on a continually presented screen). Clearly, this critique does not alter any other aspect of the claim. A more complete assessment of the RA is provided below.

2.6.3. Step 4: Assessment of Cogency

With respect to the *legitimacy* of the RA, the grounds for the argument are acceptable. The data are unambiguous insofar as they state that nurses cannot currently forward plan (though no argument is made for the view that forward planning would be desirable, and would generally support patient care). Similarly, we can be reasonably certain that the warrant offers a reason why forward planning cannot currently be carried out (though we might ask the reason for such fragmentation; it may, of course, be simply an oversight on the part of the designers). Taken together the grounds appear to be consistent with each other.

With respect to the *plausibility* of the RA, the warrant is clearly relevant to the claim, and taken as a whole the grounds appear to offer sufficient evidence for us to believe that the claim is reasonable. The rebuttal, however, refines the claim insofar as it points out that triage information should exclude the patient's name, and should support the accountability



of nurses. The rebuttal then, weakens the plausibility of the claim as it stands. Figure 7.20 shows the assessment of this RA after rating its legitimacy and plausibility.

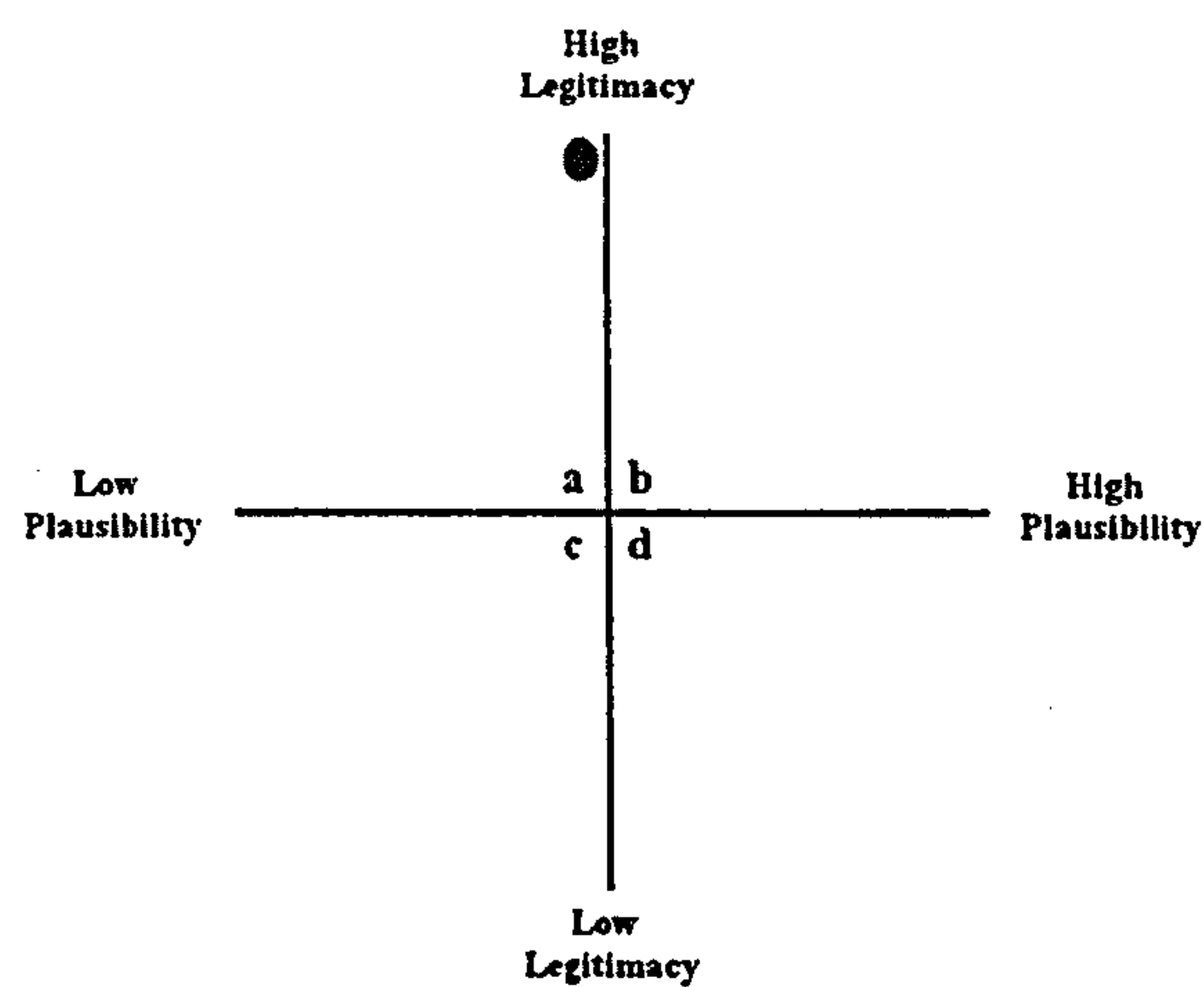


Figure 7.20: Assessment of Cogency of the RA for Requirement #6

The RA is judged to be just in Quadrant a) which means that we should seek to improve the claim. In this case, such a modification is relatively simple, insofar as we might require that patients be identified by their Casualty Number, which they are issued on registering, and that no edits be possible without the input of some form of identification (a PIN number, for example). The requirement can, thus, be reformulated as follows:

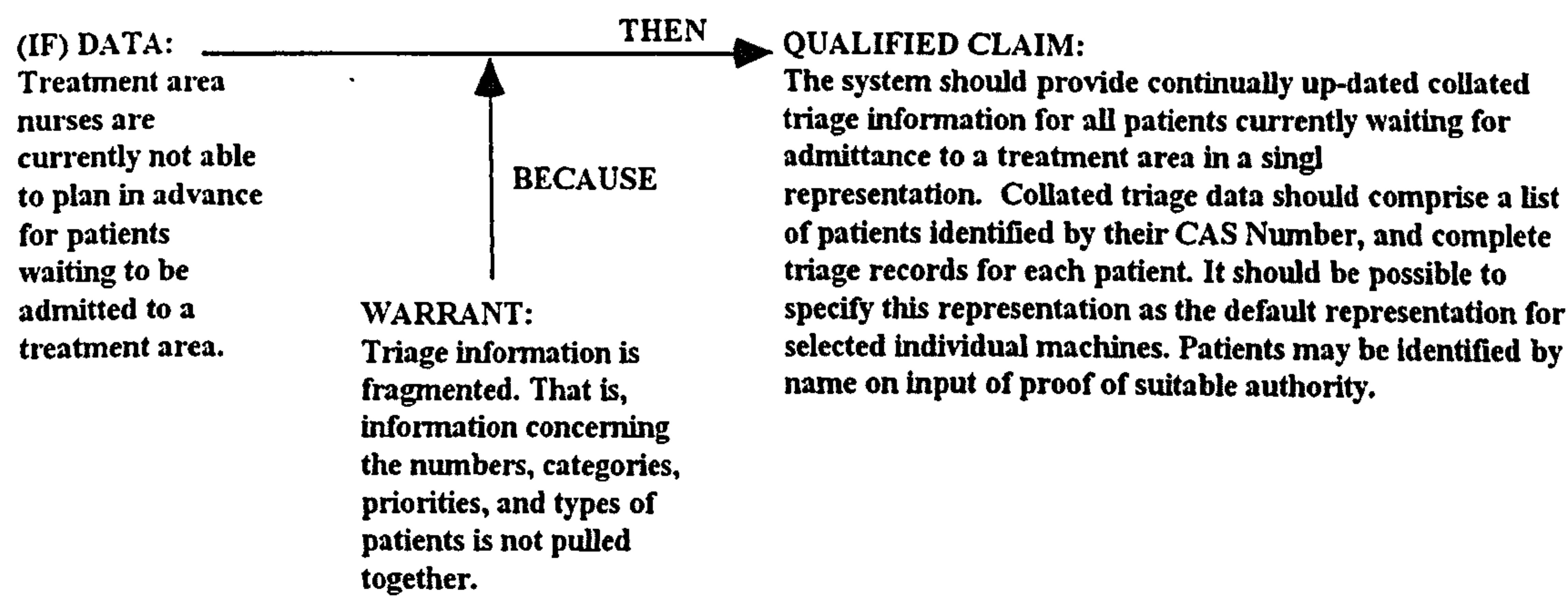


Figure 7.21: Modification of SUN Requirement #6

Analysis of Requirement #6 has shown that additional alternative information can be incorporated into the original requirement, without substantially changing the nature of its argumentation.

## 2.7. SUN Requirement #7

This section follows the three steps outlined above with respect to the seventh requirement in the SUN, which stated that:

7. The system should provide a facility to find the triage details of patients attending the department in the last 48 hours. This facility should be easily accessed from all parts of the system.

2.7.1.Step 1: Expression of Requirements Argument (RA)

A Requirements Argument (RA) for Requirement #7 is expressed in Figure 7.22:

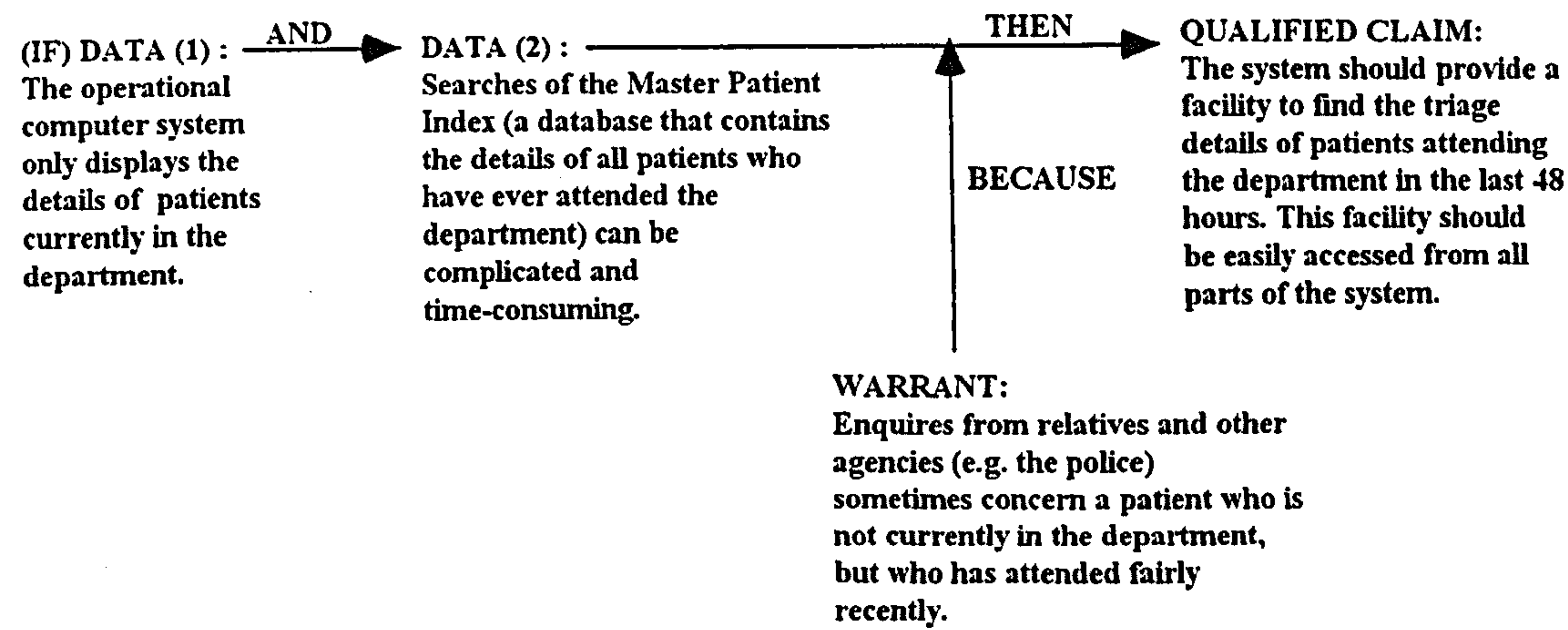


Figure 7.22: Expression of SUN Requirement #7

2.7.2.Re-expression of Requirements Argument (RA)

Grounded Theory Analysis has no comment to make on this requirement.

2.7.3.Assessment of Cogency

With respect to the *legitimacy* of this requirement, the grounds of this requirement are clearly acceptable insofar as we have no reason to believe them to be false or flawed. There are similarly consistent, coherent and complete.

With respect to the *plausibility* of the claim, the grounds are clearly relevant to the claim, and taken together appear to provide sufficient evidence for the claim.

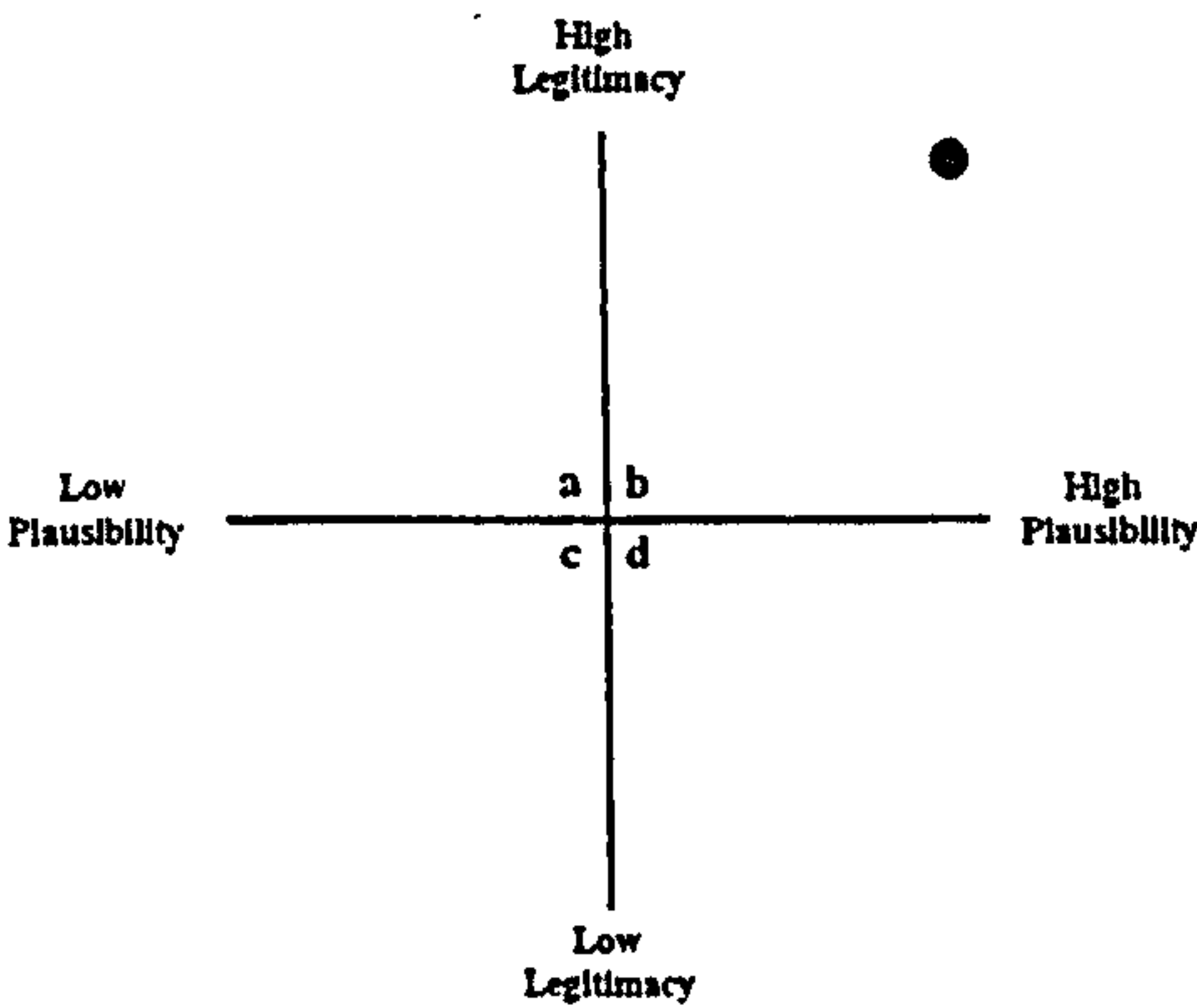


Figure 7.23: Assessment of the Cogency of the RA for Requirement #7



The RA is judged to be just in Quadrant b) which means that we should accept the requirement.

### 2.8. SUN Requirement #8

This section follows the three steps outlined above with respect to the eighth requirement in the SUN, which stated that:

8. The system should support the creation (by doctors) of digital investigation requests available to all parties as required.

#### 2.8.1. Construct Requirements Argument (RA)

A Requirements Argument (RA) for Requirement #8 is expressed in Figure 7.24:

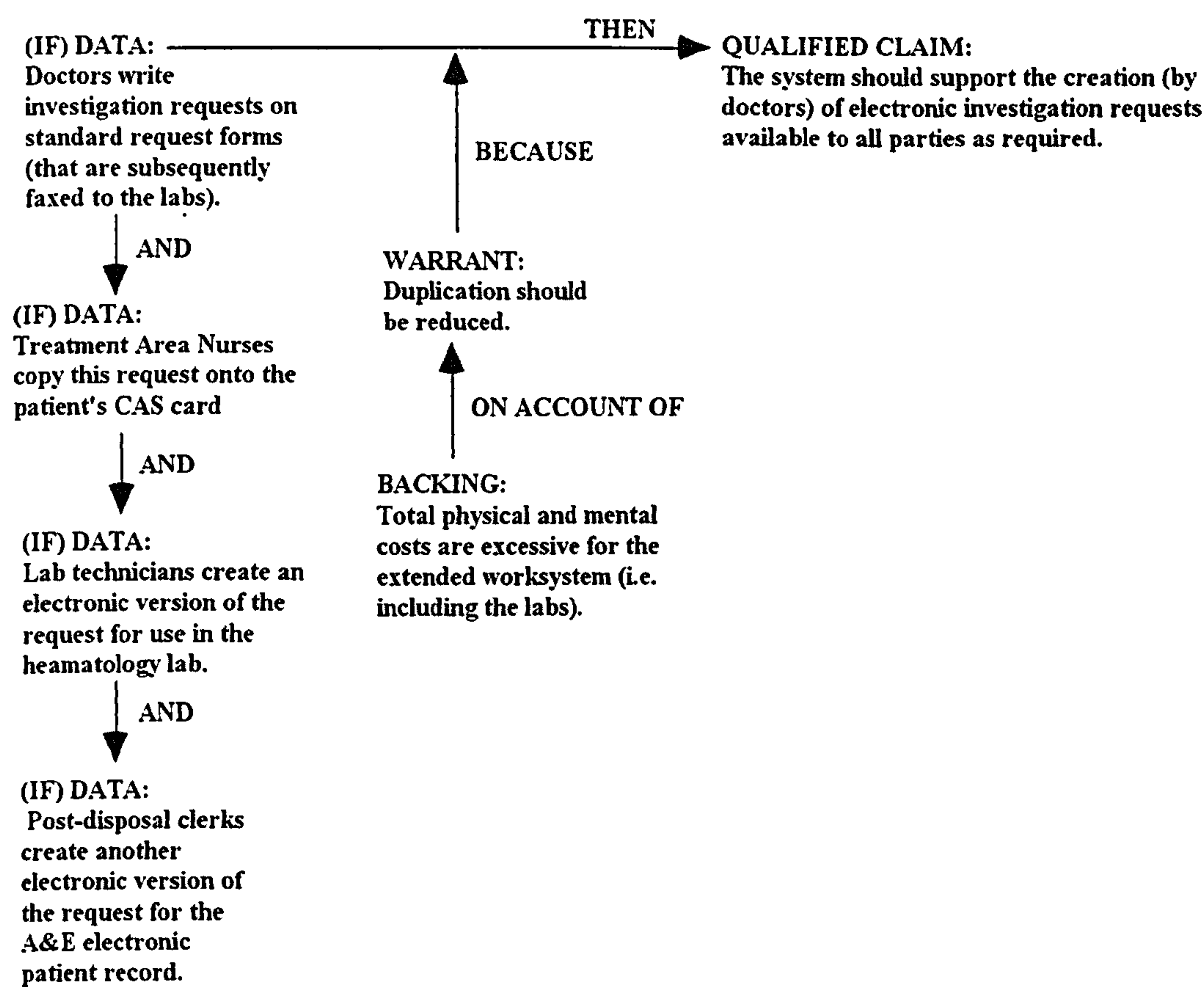


Figure 7.24: Specification of Requirement #8

#### 2.8.2. Critique Requirements Argument (RA)

Figure 7.25 critiques this requirement using information extracted from the Grounded Theory method reported in Chapter 5 (Sections 3.3.1.3 and 3.4.1).

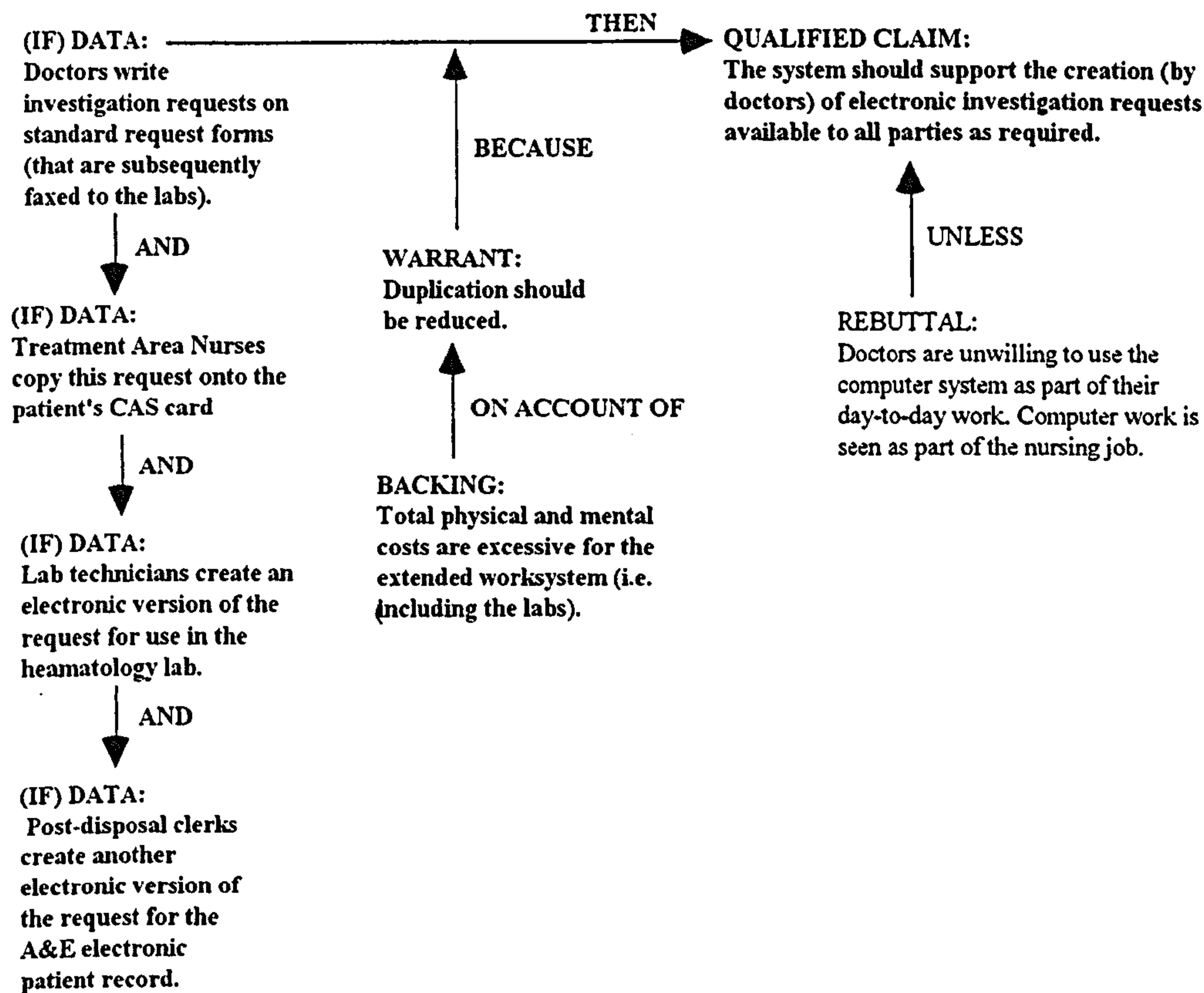


Figure 7.25: Re-Expression of SUN Requirement #8

The expression of the RA for Requirement #8 has broken down the data upon which it is based into a chain of AND statements which allow the analyst to follow the links between tasks. In this instance, such a decomposition clearly identifies the relationship between the data and the warrant that is derived from the MUSE analysis. The decomposition is not challenged in this example, but in other more complex instances the alternative analysis (e.g. Grounded Theory) may provide a chain of rebuttals to the chain of data.

### 2.8.3. Assessment of Cogency

With respect to the *legitimacy* of the RA, the grounds for the argument are acceptable. The data are explicit, and there is an obvious relationship between duplicating hand-written specification and physical user costs, so the warrant and the backing are strongly consistent with each other.

Similarly, with respect to the *plausibility* of the RA, the grounds are clearly relevant to the claim, and indeed taken together provide sufficient evidence for the claim. However, the rebuttal attacks the claim directly, and gives us cause to doubt whether doctors would indeed be willing to create electronic investigation requests. Figure 7.26 shows the assessment of this RA after rating its legitimacy and plausibility.



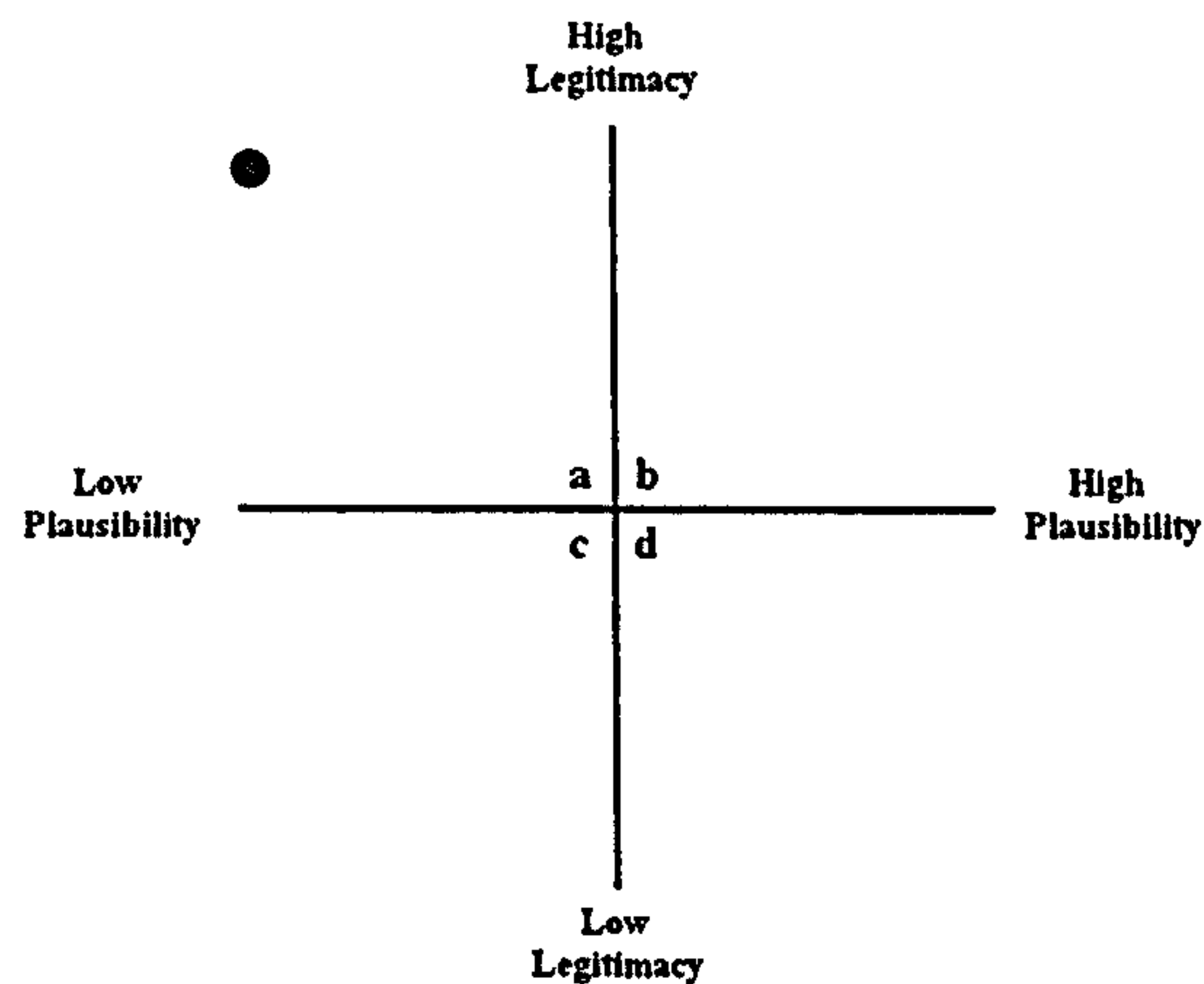


Figure 7.26: Assessment of the Cogency of the RA for Requirement #8

The RA is judged to be in Quadrant a) which means that we should improve the claim of this argument. In this case, the claim needs the most serious modification since its plausibility is judged to be very low. This requirement certainly needs a reasonable amount of extra effort before it can be accepted.

If we return to the Grounded Theory analysis, we can explore further the view that doctors are unwilling to use the computer system. Doctors perceive their rôle to be one of clinical care, and perceive the nurses' rôle to be essentially one of administration, patient co-ordination, and patient care. In looking for improvements to the claim, then, we might look to the role of nurses in supporting doctors in providing electronic specifications. That is, the doctor may write the specification on the patient's CAS card (a small change in operational procedures), which the nurse will then use to create an electronic version that can be made available to the labs (and any other relevant parties, including the post-disposal clerks). It should be noted, however, that authorisation for the investigation is now transposed from the request form to the CAS card. This general strategy has a number of implications (not least for the nurses who would now be the direct recipients of the effort which the doctors and other A&E staff have saved). Also, as we have noted in Requirement #1, nurses often worry about public perception of their computer use in the context of patients needing care. This worry is especially prevalent in triage which is a very public role, and is less of an issue on majors and minors, where most of the requesting of investigations is carried out. Additionally, the nurses themselves will save a considerable amount of time, and frustration, by virtue of not having to queue for the fax machine in order to send requests to the labs. This last point is explored further when we discuss Requirement #12.

The new requirement can be represented as follows:

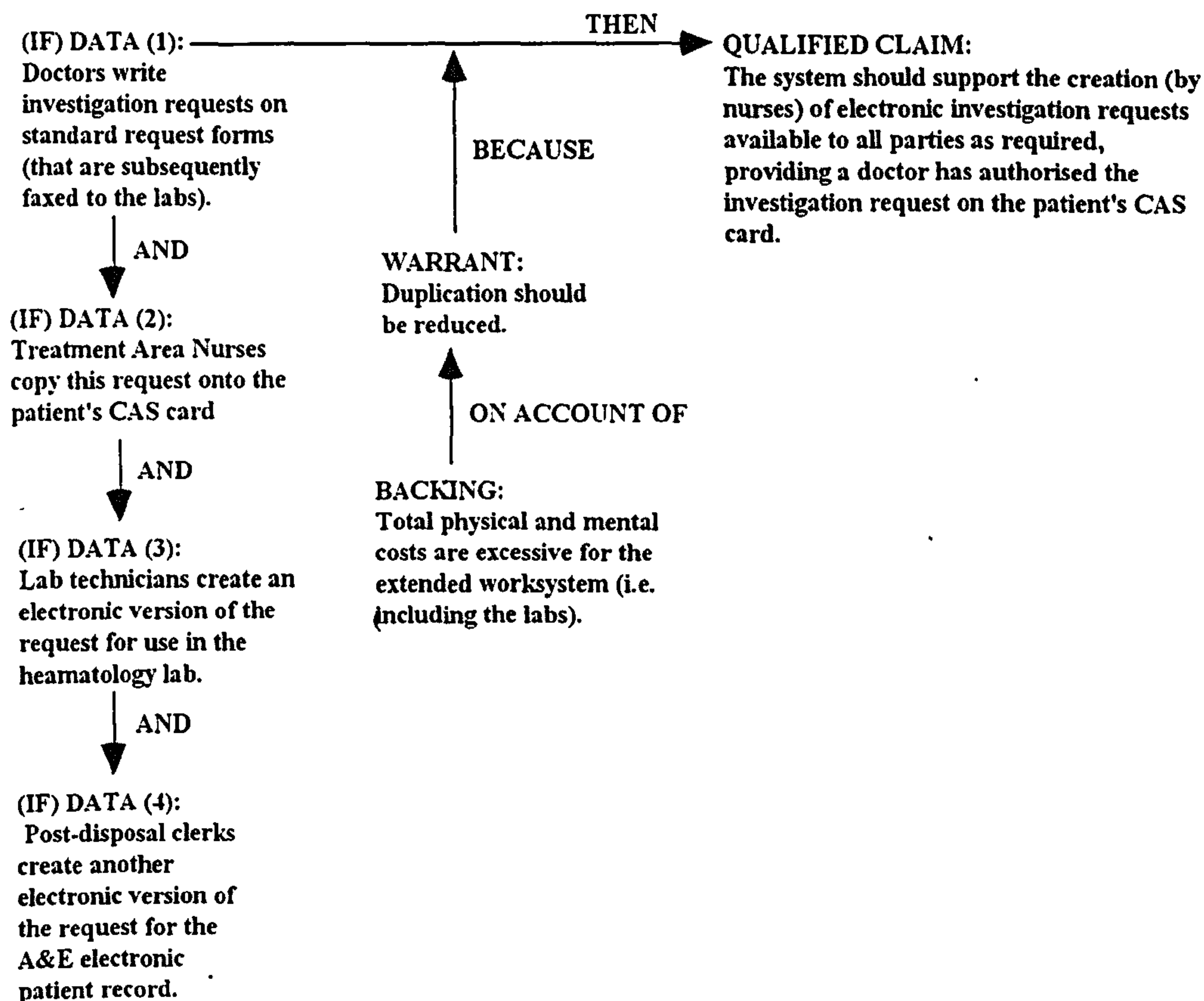


Figure 7.27: Re-Expression of Requirement #8 after Resolution

## 2.9. SUN Requirement #9

The ninth requirement in the SUN, stated that:

9. The system should support the creation (by lab technicians) of electronic investigation results, available to all parties as required.

There is no need here to complete a full analysis of this requirement, since the arguments are basically identical to those above, but without a rebuttal in this case, since the lab technicians use the computer system on a day-to-day basis and, therefore, would not have the same resistance to the use of the computer system that was suggested for doctors. This requirement can, therefore, be accepted as it stands.

## 2.10. SUN Requirement #10

The tenth requirement in the SUN, stated that:

10. The post-disposals EPR should be updated automatically on the creation of electronic investigation requests/results (and should be automatically amended if these are themselves amended).

Again, this requirement does not need to be amended, since once electronic investigation request/results are created (regardless of whom they are created by) their inclusion on the



patient’s electronic record would be mandatory, and under these circumstances automatic inclusion is clearly beneficial since it reduces workload for post-disposal clerks.

## 2.11. SUN Requirement #11

The eleventh requirement in the SUN, stated that:

- 11. The A&E system and the pathology system should be compatible, and should be linked by an appropriate network.

Again, this requirement does not need to be amended, since it is essentially specifying a technical hardware/networking requirement, upon which the exchange of digital communications of the sort discussed above can take place.

## 2.12. SUN Requirement #12

This section follows the three steps outlined above with respect to the twelfth requirement in the SUN, which stated that:

- 12. The system should support the on-line asynchronous communication of electronic investigation requests/ results between the treatment areas and the haematology labs.

### 2.12.1. Construct Requirements Argument (RA)

A Requirements Argument (RA) for Requirement #12 is expressed in Figure 7.28:

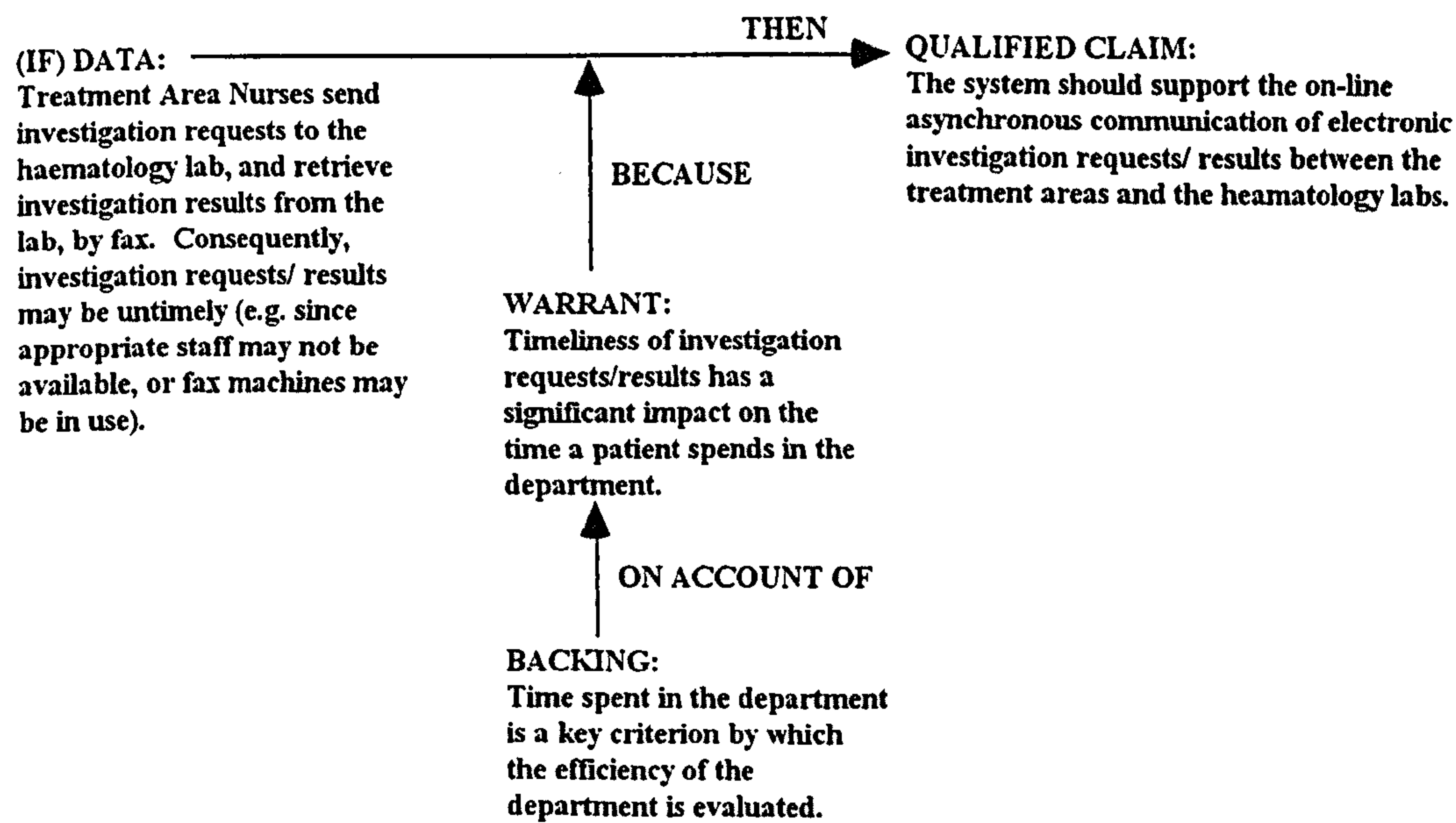


Figure 7.28: Specification of the RA for Requirement #12

2.12.2. Critique Requirements Argument (RA)

Figure 7.29 critiques this requirement, using information extracted from the Grounded Theory method reported in Chapter 5 (Sections 3.3.2.3 and 3.5.3), and importantly in this case by returning to the MUSE analysis (the two analyses are distinguished as elsewhere with bold type for the MUSE analysis and plain type for the Grounded Theory method).

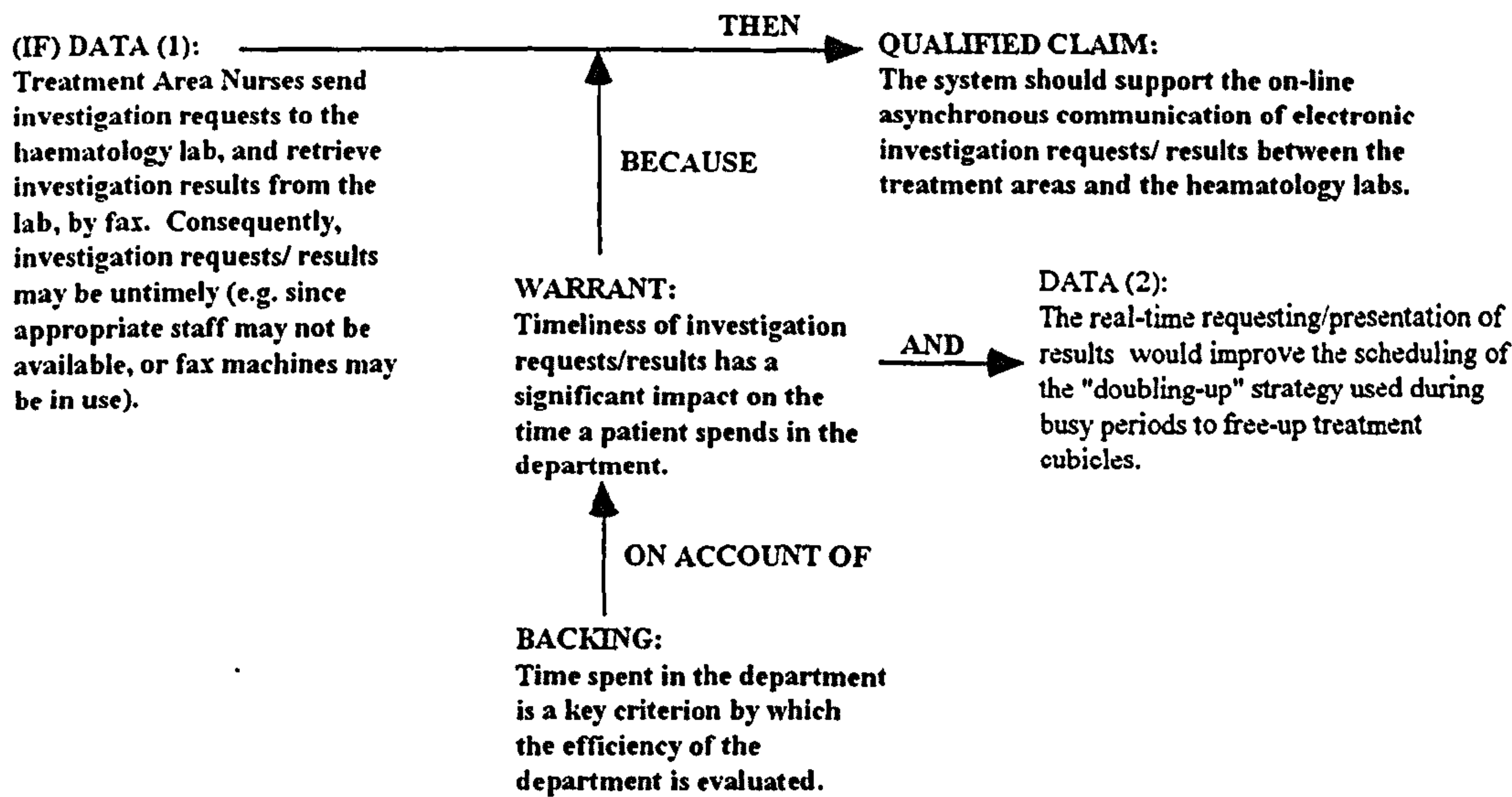


Figure 7.29: Critique of the RA for Requirement #12

2.12.3. Assessment of Cogency

With respect to the *legitimacy* of the RA, the data, the warrant and the backing are all consistent with one another, and give us good reason to accept the grounds, particularly since the second data item provides additional support to the original grounds.

With respect to the *plausibility* of the claim, the grounds are clearly all relevant to the claim, and are clearly sufficient to support the claim. Figure 7.30 shows the assessment of this RA after rating its legitimacy and plausibility.



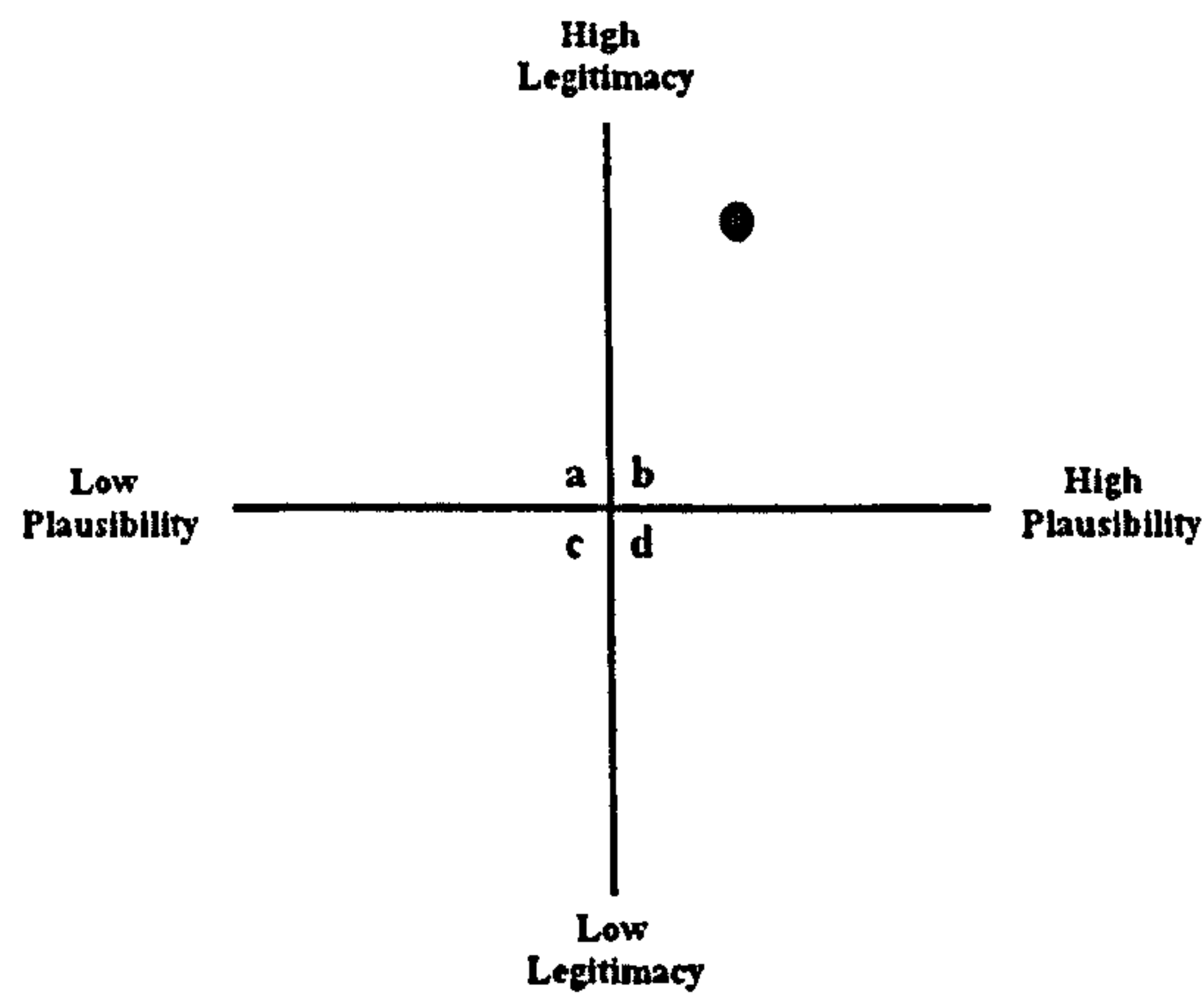


Figure 7.30: Assessment of the Cogency of the RA for Requirement #12

The RA is judged to be just in Quadrant b) which means that we can accept this requirement.

## 2.13. SUN Requirement #13

The thirteenth requirement in the SUN stated that:

13. The system should preserve the standard format of electronic investigation requests/results during asynchronous communication.

There is no need here to complete a full analysis of this requirement, since the requirement is essentially arguing for a particular technological approach; that is, it is arguing that the computer system should be WYSIWIS (what you see is what I see). We can illustrate the need for this technology with an example of a WYSIWIS failure commonly occurring during communication between incompatible e-mail systems where a £ sign is sometimes received by the recipient as A3. This requirement can be accepted as is.

## 2.14. SUN Requirement #14

This section follows the three steps outlined above with respect to the fourteenth requirement in the SUN, which stated that:

14. The system should support synchronous shared access (throughout the hospital) to electronic investigation requests.

### 2.14.1. Construct Requirements Argument (RA)

A Requirements Argument (RA) for Requirement #14 is expressed in Figure 7.31:

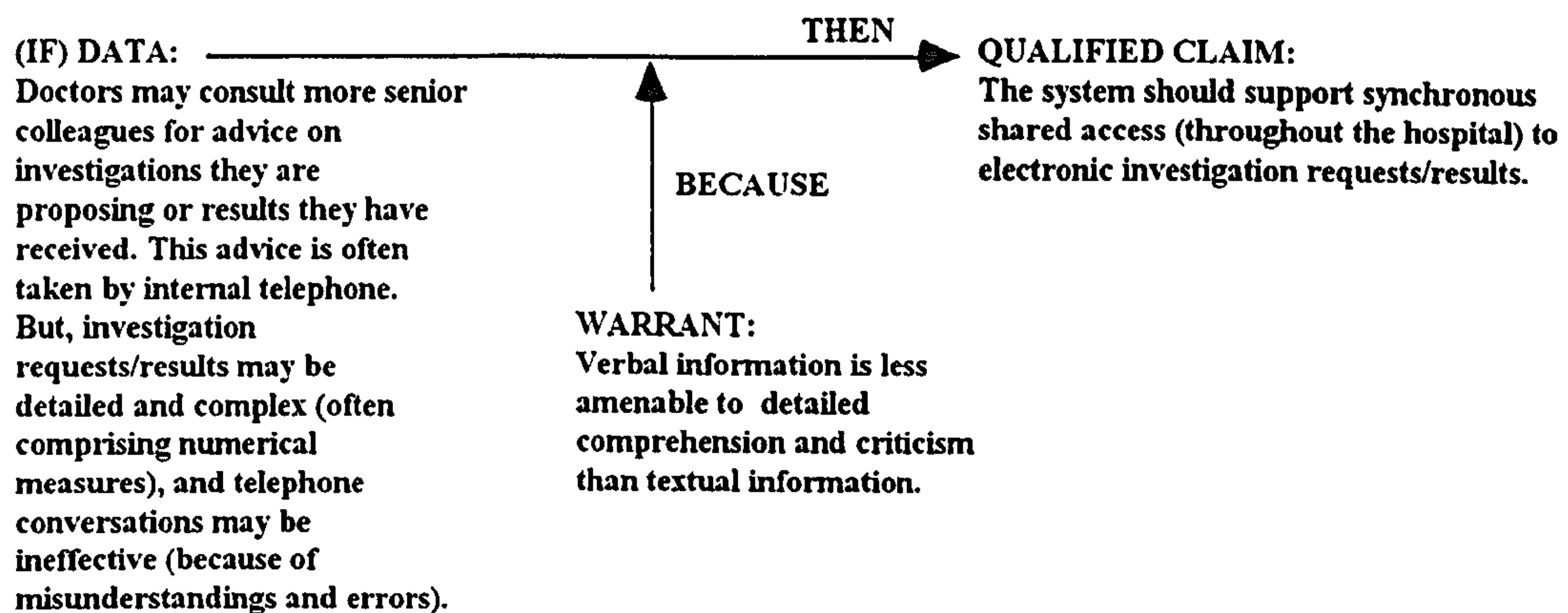


Figure 7.31: Specification of the RA for Requirement #14

## 2.14.2. Critique Requirements Argument (RA)

Figure 7.32 critiques this requirement using information extracted from the Grounded Theory method reported in Chapter 5 (Section 3.3.1.3).

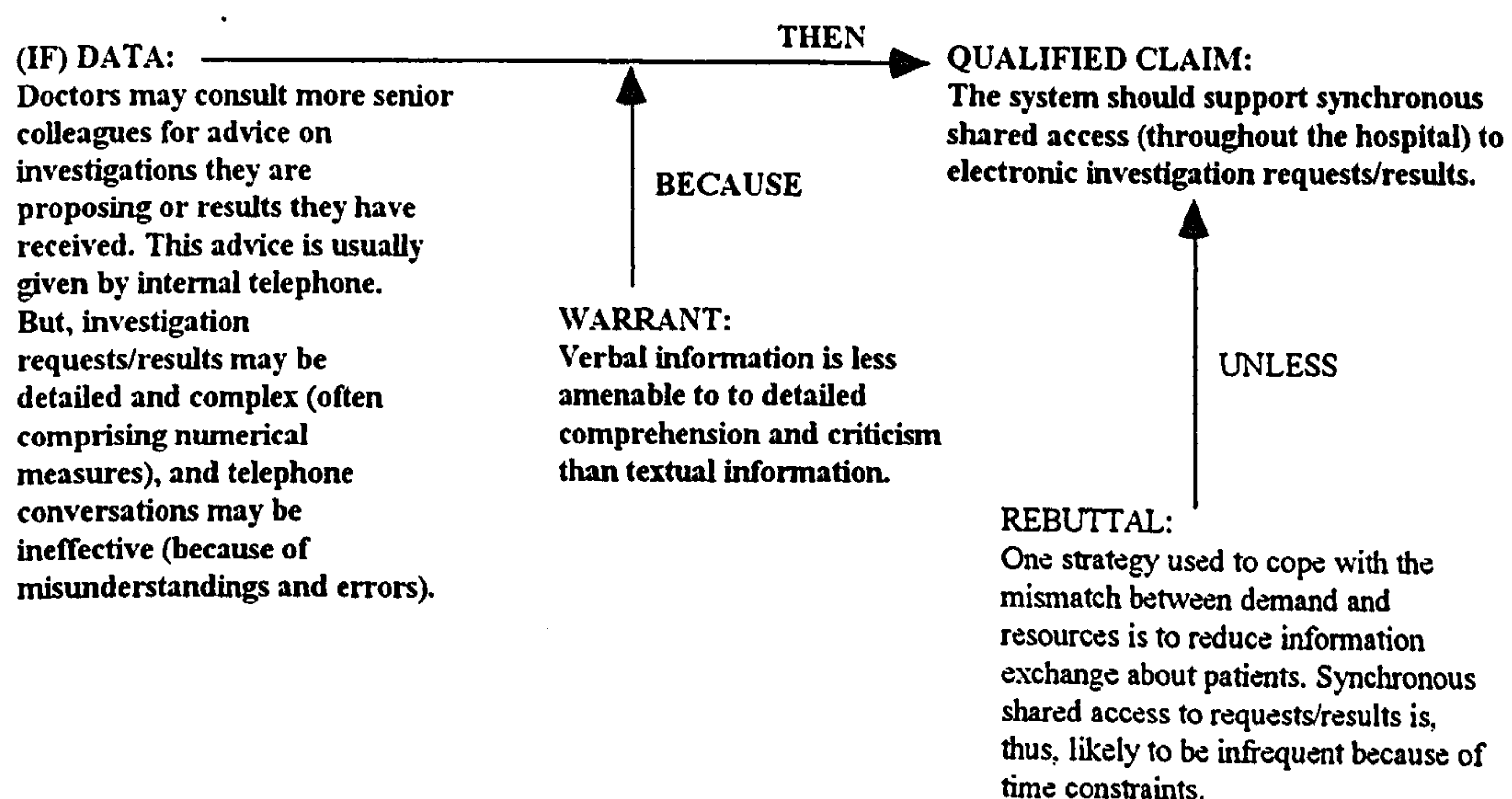


Figure 7.32: Critique of the RA for Requirement #14

## 2.14.3. Step 4: Assessment of Cogency

With respect to the *legitimacy* of the RA, the data are less explicit than they might be. For example, the data do not quantify the frequency of such consultations, or indeed the resulting errors. The data and the warrant, however, are consistent and coherent, though the RA is incomplete insofar as there is no backing provided (though this would appear not to be a major flaw in the argument in this case).



With respect to the *plausibility* of the RA, the data and the warrant are clearly relevant to the claim, and would be sufficient to make the claim plausible if the data were clarified. For the moment, then, we might think of the grounds as being provisionally sufficient (giving the benefit of the doubt to the RA, rather than to the rebuttal). Figure 7.33 shows the assessment of this RA after rating its legitimacy and plausibility.

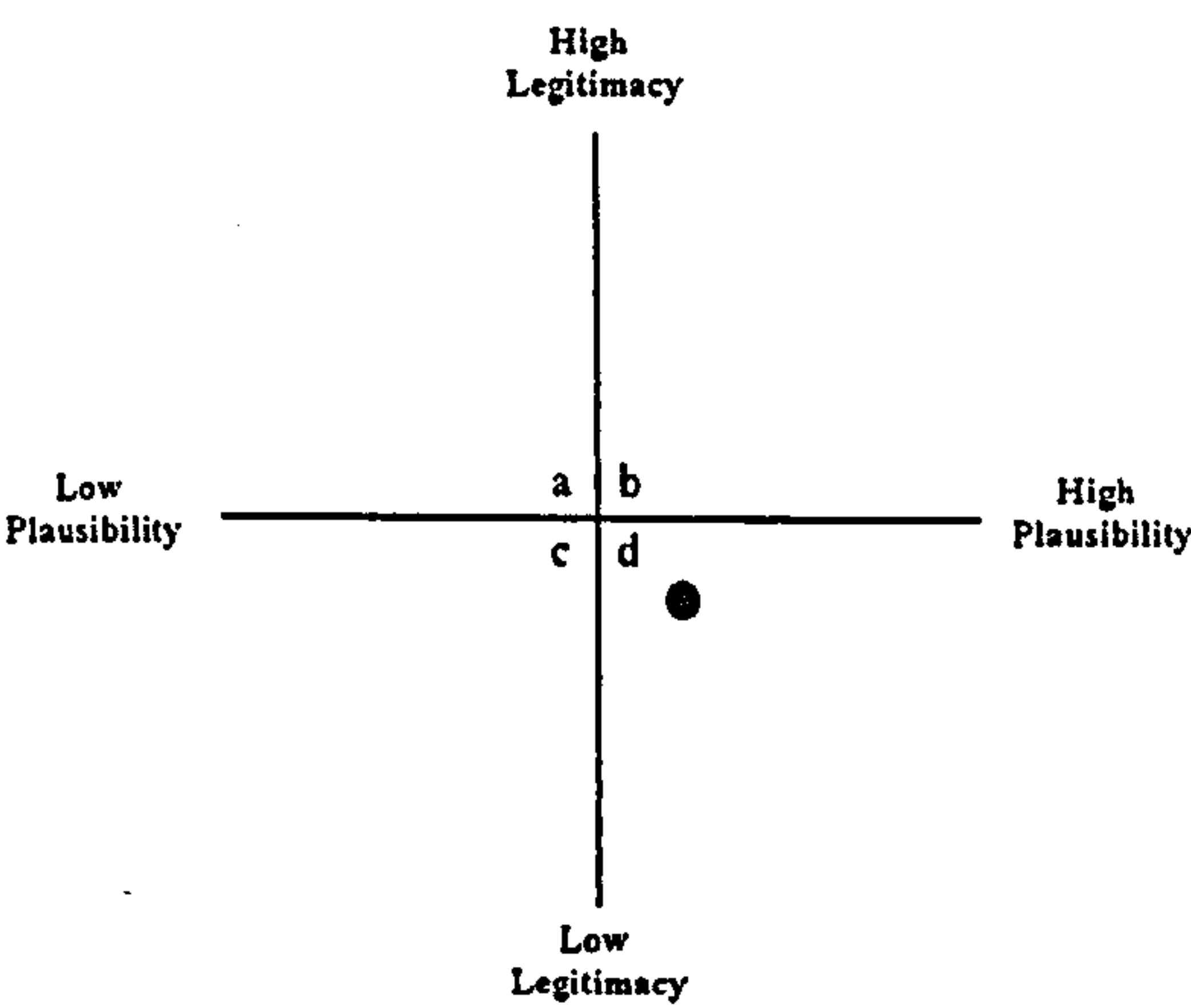


Figure 7.33: Assessment of the Cogency of the RA for Requirement #14

The RA is judged to be just in Quadrant d) which means that before we can accept this requirement we would have to conduct further research on the data on which this requirement is based. Unfortunately such research is not practicable at time of writing (but could be conducted in principle).

### 3. Comparison of Original and Revised Requirements

Table 7.1 presents the original requirements as expressed in the SUN, alongside the revised requirements resulting from the application of the dialectic approach.

<p><b>Target System Task 1: Record Triage Information</b></p> <ol style="list-style-type: none"> <li>1. The system should obviate the need for triage nurses to create hand-written triage information. That is, triage information should be prepared solely in electronic form.</li> <li>2. Triage information pertaining to a patient episode must be made available in a physical representation once a patient is admitted to a treatment area.</li> <li>3. The system should minimise the time taken by triage nurses to input triage data to the electronic patient record (performance improvements may be assessed with respect to current input times).</li> <li>4. The system should automatically calculate and record triage times.</li> <li>5. The system should include computer-based clinical thesauri to support the rapid formulation of standardised problem descriptions by triage nurses.</li> </ol>	<ol style="list-style-type: none"> <li>1. Triage nurses should create hand-written triage information, which should be converted into electronic form by another class of member of the A&amp;E staff (e.g. administrative staff).</li> <li>No change.</li> <li>3. The system should minimise the time taken by administrative staff to input triage data to the electronic patient record.  Further data collection and analysis would be required before this requirement could be fully accepted.</li> <li>4. Triage nurses should elicit information from, and provide information to, patients in a manner commensurate with the their professional judgement, provided they give due care and attention to the time limits stipulated by the Patient's Charter.</li> <li>5. Triage nurses may record all relevant information concerning the physical, mental, emotional and social state of a patient, providing they give due care and attention to the time limits stipulated in the Patient's Charter.</li> </ol>
<p><b>Target System Task 2: Communicate Triage Information</b></p> <ol style="list-style-type: none"> <li>6. The system should provide continually up-dated collated triage information for all patients currently waiting for admittance to a treatment area in a single computer representation. Collated triage data should comprise a patient list and complete triage records for each patient. It should be possible to specify this computer representation as the default representation for selected individual machines.</li> <li>7. The system should provide a facility to find the triage details of patients attending the department in the last 48 hours. This facility should be easily accessed from all parts of the system.</li> </ol>	<ol style="list-style-type: none"> <li>6. The system should provide continually up-dated collated triage information for all patients currently waiting for admittance to a treatment area in a single computer representation. Collated triage data should comprise a list of patients identified by their CAS Number, and complete triage records for each patient. It should be possible to specify this representation as the default representation for selected individual machines. Patients may be identified by name on input of proof of suitable authority.</li> <li>7. No change</li> </ol>

Table 7.1: Comparison of the Original and the Revised Requirements (Table continued overpage)



<p><b>Target System Tasks 3 &amp; 5: Record Investigation Requests/Results</b></p>	
8. The system should support the creation (by doctors) of electronic investigation requests, available to all parties as required.	8. The system should support the creation (by nurses) of electronic investigation requests available to all parties as required, providing a doctor has authorised the investigation request on the patient's CAS card.
9. The system should support the creation (by lab technicians) of electronic investigation results, available to all parties as required.	9. No change
10. The post-disposals EPR should be updated automatically on the creation of electronic investigation requests/results (and should be automatically amended if these are themselves amended).	10. No change
11. The A&E system and the pathology system should be compatible, and should be linked by an appropriate network.	11. No change
<p><b>Target System Task 4 &amp; 6: Communicate Investigation Requests/Results</b></p>	
12. The system should support the on-line asynchronous communication of electronic investigation requests/ results between the treatment areas and the haematology labs.	12. No change
13. The system should preserve the standard format of electronic investigation requests/results during asynchronous communication.	13. No change
14. The system should allow synchronous shared access (throughout the hospital) to electronic investigation requests/results.	14. Inconclusive. Further data collection and analysis would be required before this requirement could be fully accepted.

Table 7.1: Comparison of the Original and the Revised Requirements (continued)

From Table 7.1 we can see that six of the original fourteen requirements specified in the SUN have been modified through the application of the dialectic approach (Nos: 1, 3, 4, 5, 6, 8). Of these six requirements; five have been modified outright (Nos: 1, 4, 5, 6, 8); and one (No 3) requires further data collection and analysis effort before it could be accepted.

Of the eight remaining requirements: seven can be accepted as they stand; that is, no change is recommended (Nos: 2, 7, 9, 10, 11, 12, 13); and one requires further data collection and analysis before a judgement can be made as to what action to take (No 14). We should note here that Requirement #12 was only accepted after further argumentation mediated by the dialectic approach.

In sum, then, a mutual influence of discipline contributions has been observed (via the dialectic approach) between seven out of the original fourteen requirements (i.e. 50%). Of these seven; five resulted in modifications; one resulted in the need for further data collection and analysis; and one was accepted after further argumentation.

Figure 7.34 summarises the cogency assessments of the RAs for the six requirements that have been modified. For completeness, the figure also shows Requirement #12 which was accepted after additional argumentation.

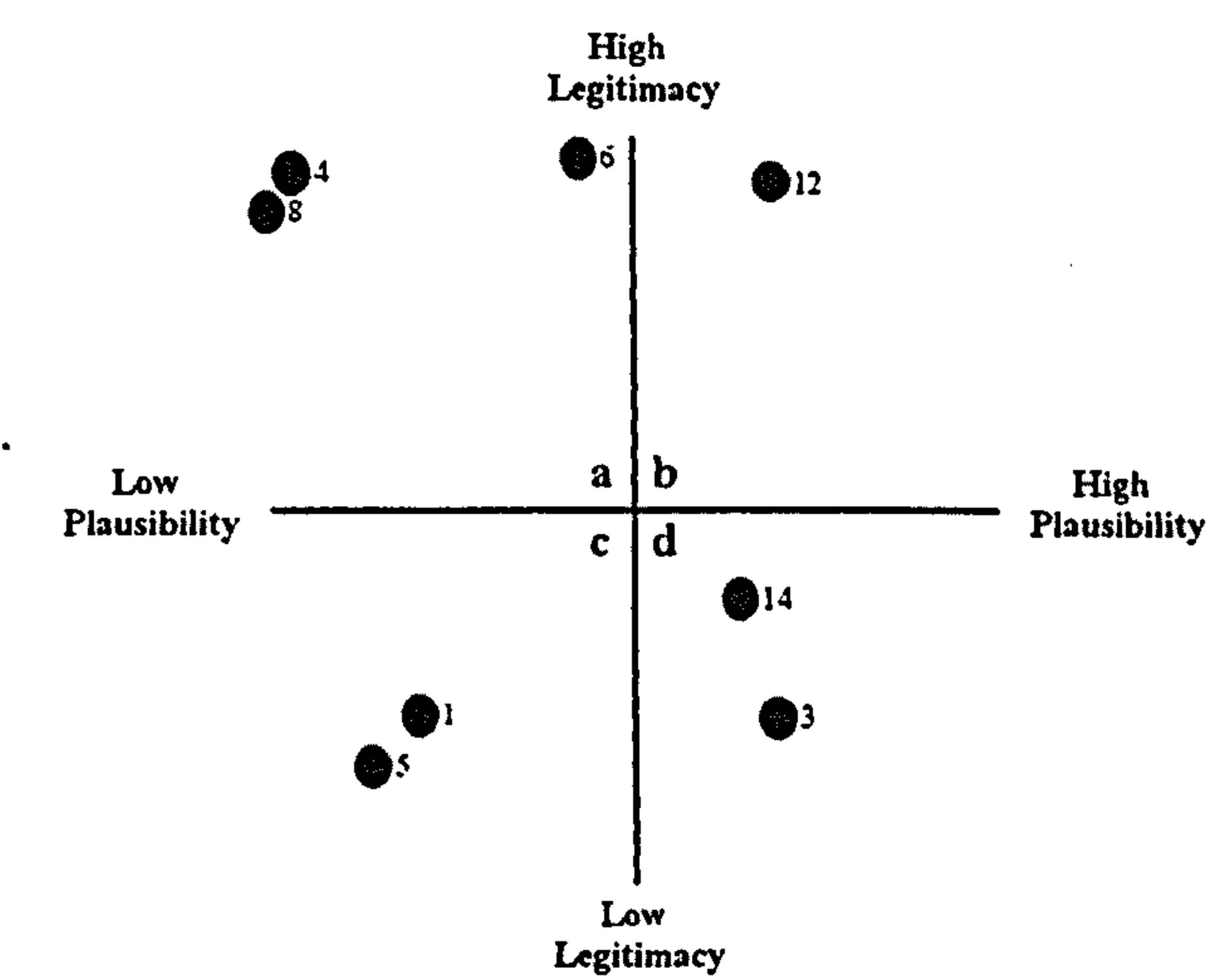


Figure 7.34: Summary of Cogency Assessments of the RAs Modified Via Application of the Dialectic Approach

From Figure 7.35, we can see that: Requirements 4, 6 and 8 were subject to an improvement in their claims; Requirements 3, and 14 were subject to an improvement in their grounds; and Requirements 1 and 5 were subject to a synthesis of opposing views. By relating Table 7.1 to Figure 7.34 we can offer further, more general, interpretations of the reasons why these requirements were modified.

For example, Requirements 4 and 8 were subject to improvement in their claims, because although they offered apparently sound technical requirements, which if implemented might overcome existing problems in the A&E department (that is: that triage times should be



calculated automatically to overcome the problem of false recording of triage times; and that doctors should be able to create electronic investigation requests to overcome the duplication between manual and electronic systems), these technical solutions did not take into account the social aspects of the work (that is: that triage nurses had good reason for false reporting; and that doctors do not use the computer system as part of their operational work).

Similarly, Requirements 1 and 5 were subject to a synthesis of opposing views, since although they proposed apparently sound technical requirements, which if implemented might overcome existing problems in the A&E department (that is: that triage nurses should only record triage data electronically to overcome the duplication between manual and electronic systems; and that triage nurses should be supported in problem formulation by the use of clinical thesauri to overcome the problem of informal and idiosyncratic problem descriptions), they did not take into account the perspective of the actors on the nature of the work (that is: the importance of the nurse-patient interaction; and the importance of recording all information having a bearing on a patient's well-being).

As for Requirements 3 and 14, their grounds were subject to improvement, since they failed to properly demonstrate their relevance to the work of the department. The extra data collection and analysis proposed here, might save considerable effort in designing and implementing systems which might ultimately not be used.

In general, although the dialectic approach is labour intensive, the fact that 50% of the originally proposed requirements were subject to comment and modification points to the fact that in the long run such effort may be time well spent, at least insofar as the requirements appear to more accurately reflect the requirements of A&E department. The converse of this view, is that we can be reasonably certain that the other 50% of requirements will be appropriate. Additionally, for the 50% that are modified, it may be important to monitor and assess their success when implemented, since we might have good reason to believe that they are less robust than those requirements that have been accepted without modification.

## **4. Outcome of the Application with respect to the Redesign of the A&E Healthcare Information System**

The revised requirements produced by the application of the operationalisation have been used by the software developers as the basis for new designs and a new software product for the A&E department in question.

The use of the requirements by the software developers can be taken as an endorsement of them (and by implication the utility of the dialectic approach), since the developers have considerable experience in the healthcare domain, and would immediately reject any requirement which in their view was spurious to the needs of the healthcare sector, or would adversely affect the success of their software product. Evidently, the use of the requirements by the software developers is not as firm an endorsement as that which might be provided by the users themselves, but it has not been possible to evaluate the redesigned system with users because of financial/political problems within the hospital. Specifically, the hospital management has decided that it is not politic for the A&E department to be allocated further resources to install a re-designed system whilst other hospital departments are still awaiting their first system implementation. Similarly, permission to test the re-designed system with users in A&E was refused in order not raise expectations, and to exacerbate the situation. The A&E system has been scheduled to be implemented following the roll-out of an inpatient management system to all hospital wards, and is likely to go ahead in 1999.

## **5. Summary**

This chapter has applied the operationalisation of the dialectic process and its products in the redesign of an A&E healthcare information system. The next chapter assesses this application, and uses this assessment as the basis from which to reconceptualise the dialectic process and its products.



## Chapter Eight

### **Conclusions on the Dialectic Approach: Assessment, Re-Conceptualisation and Suggestions for Future Work**

Knowledge is inevitably practical.

Jean-Paul Sartre (1976)

#### **1. Introduction**

In Chapter 2, we suggested that overcoming the problems associated with dependent multidisciplinary practice by practitioner (as identified in Chapter 1) depends upon the practical accommodation of paradigms. We also proposed a number of criteria which, if met, would support the practical accommodation of paradigms, and hence support dependent multidisciplinary practice by practitioner.

This chapter assesses the ability of the operationalisation of the dialectic approach (that is, the operationalised dialectic process and the operationalised dialectic product) to support the accommodation of paradigms with respect to these criteria. This assessment is then used to reconceptualise the dialectic process and its products. Finally, the limitations of the research are identified, and possibilities for future work proposed.

#### **2. Assessing the Operationalisation of the Dialectic Approach (with respect to the Criteria)**

In Chapter 2, we proposed a number of criteria which, if met, would support the practical accommodation of paradigms, and hence support dependent multidisciplinary practice by practitioner. For convenience, these requirements are shown again in Table 8.0 below.

**A. Criteria for the social-community accommodation of paradigms**

Any approach that aims to support the practical accommodation of paradigms should:

- 1) Support multiparadigmatic contributions to the same inquiry (Austin, 1990).
- 2) Help practitioners understand the key issues of each paradigm (Crandall, 1990)
- 3) Help practitioners appreciate the views of those operating in a different paradigms (Austin, 1990).
- 4) Allow each paradigm to express itself independently of the other (Burrell and Morgan, 1979).
- 5) Help improve communication between practitioners of different paradigms (Guba and Lincoln, 1989)
- 6) Help practitioners understand the practical implications of alternative paradigm positions (Skrtic, 1990).
- 7) Help practitioners understand alternative beliefs (Burrell and Morgan, 1979).
- 8) Help practitioners understand the values and norms of alternative paradigms (Schön, 1983).

**B. Criteria for the individual accommodation of paradigms**

Any approach that aims to support the practical accommodation of paradigms should:

- 9) Bring the role of the paradigm into the realm of conscious thought (Schön, 1983).
- 10) Support practitioners in the conscious articulation of alternative paradigm positions (Crandall, 1990)
- 11) Help practitioners change their own behaviour and beliefs (Le Compte, 1990).
- 12) Help practitioners use different vocabularies (Barbour, 1980; Jackson and Carter, 1991)
- 13) Support practitioners in the enumeration of specific paradigm positions and criticisms (Reinharz, 1981).
- 14) Support practitioners in the management of commitment and critical reflection (Reinharz, 1981).

Table 8.0: Criteria for an Approach to Support the Practical Accommodation of Paradigms

This section assesses the success of the operationalisation of the dialectic process and its products in meeting these criteria. The assessment is based on the application of the approach to the design of an A&E healthcare information system as described in Chapter 7. Again for convenience, the processes and products of the dialectic approach and its operationalisation are summarised in Table 8.1.



Process	Operationalised Process	Product	Operationalised Product
Reflection	Construct Requirements Argument	Understanding	Specification of Data, Claim, and Warrant
Negative Reasoning	Critique Requirements Argument	Dialectic Comment	Specification of Rebuttals and Qualifiers
Positive Reasoning	Assess Requirements Argument and Act on this Assessment	Resolution	Statement of Cogency of Requirements Argument and Planned Actions

Table 8.1: Dialectic Processes, Products and their Operationalisation

### 2.1. Assessment of the Operationalisation: “Construct the Requirements Argument/Specification of Data, Claim and Warrant”

In Chapter 3, we suggested that reflection is essential if a practitioner is to be able to examine (and sometimes overcome) their biases about what requirements are, what they ought to be, why they are the way they are, how they can be gathered and represented and so on. We also suggested that this practitioner-based information (as well as the reasons, rationale and assumptions underlying it) must be made explicit, so that the basis of their judgement can be brought to the surface for examination (Esterson, 1972).

The framework for argumentation operationalises reflection, insofar as it makes clear all the assumptions upon which the data, warrant, background and claims of a requirement are based. More particularly, however, it requires that practitioners learn to reason (in a coherent and logical fashion) from the claim to the grounds for that claim and back again.

For example, each requirements argument in the application of the dialectic approach described in Chapter 7 was constructed by starting with the claim (i.e. the requirement) and then constructing the data, warrant and backing. This approach was taken because each requirement is represented in the Statement of User Needs (SUN), but the data, warrant and backing upon which the claim is based may either: reside elsewhere in the MUSE analysis; may be implicit in that analysis; or may be absent from the analysis.

The need to construct the requirements argument by ‘reverse engineering’ the grounds from the claim demands consideration of the nature of the reasoning used in the MUSE



method, and may involve a search for implicit/absent logic in the reasoning lying behind the requirements represented in the SUN.

For example, in Chapter 3, the reasoning behind the SUN requirement #1 is discussed, and the ineffectiveness of duplication of triage information explained in terms of the fact that hand-written information is always converted to electronic form. Ineffectiveness, then, is a major constituent of the *warrant* to the claim, but ineffectiveness is not explained as a concept, and the reasons why duplication is ineffective <sup>are</sup> ~~is~~ not explained further. Similarly, the *backing* to the requirements argument, which draws on the concept of workload, again says little about how to interpret this concept in the context of the work of triage nurses.

The realisation that the requirement argument is based on grounds that, at the very least, may need further explanation, may prompt the practitioner to consider their own biases, assumptions and preferences that were perhaps taken for granted when the requirement was formulated. For instance, in the current example, the practitioner (that is, the author) was very familiar with concepts such as workload and ineffectiveness. These concepts are not only embedded in the method, but also embedded in the practitioner's own analytic style, and can be thought of as HF discipline concepts brought to the investigation by the practitioner. However, the explicit nature of the argumentative process highlighted that these concepts needed further explication, and as such might be thought of as meeting (in some measure) the following criterion for successful support:

- 13) Support practitioners in the enumeration of specific paradigm positions and criticisms (Reinharz, 1981).

In this sense, then, the search for implicit/absent logic to the reasoning behind requirements, then, makes practitioners aware of the way that they have framed the requirements problem, and alerts them to the possibility of alternative ways of framing it (Schön, 1983).

Furthermore, when examining the *backing* to a requirement, practitioners may examine the underlying assumptions of the technique which generated those requirements (e.g. what does this technique take for granted?). In the current example, MUSE is based on a 'consensus' conception of human factors design that sees system performance as a function of environment, task, device and user characteristics (Lim and Long, 1994).

By examining the *data* on which a requirement is based, practitioners might seek to identify how the concepts they supply to practice influences how the data are elicited and represented. MUSE, for example, provides procedural knowledge about how to conduct task performer interviews, and how to process such information into Extant Systems Analysis products.

By examining the *warrant* that justifies a requirement, practitioners may seek to identify the benchmarks of rigour that they have used to justify a claim, and the ontology, epistemology, and methodology that they are appealing to (e.g. MUSE assumes an external



reality characterised as work performed by systems, and is concerned with generalisable knowledge associated with objectively observable behaviours, and the verification of specifications via testing - see Chapter 3).

Finally, when examining the *claims* made by a requirement, practitioners may seek to identify the fundamental values and beliefs embodied in the requirement (MUSE assumes, for example, that human behaviours are at least to some extent deterministic).

The dialectic approach, then, generates a deeper understanding of the current assumptions that have underpinned the development of interactive system requirements, and also a deeper understanding of alternative assumptions that could be used instead. The approach may also provide an appreciation of the fact that different stakeholders conceive of requirements in different ways, and why it is important to respect such differences.

Making such assumptions explicit has the benefits of allowing judgements to be made about the efficacy of the assumptions, raises pertinent issues that might have otherwise been ignored, and also stimulates doubt (Mason and Mitroff, 1981), which is the subject of the next section which addresses negative reasoning and the critique of a requirements argument.

## **2.2. Assessment of Operationalisation: “Critique the Requirements Argument/Specification of Rebuttals and Qualifiers”**

In Chapter 3, we suggested that negative reasoning serves the purpose of unearthing assumptions, testing our prejudices, and challenging our existing concepts (Posner et al, 1982). In the process of determining opposing arguments, and specifying rebuttals to requirements and their grounds, practitioners undergo a process of discovering inadequacies in their arguments by explicitly looking for conflicts between the outputs of different requirements models and techniques.

The framework for argumentation operationalises negative reasoning, insofar as it supports reasoning about rebuttals, qualifiers, counter requirements and their assumptions.

Specifying a *rebuttal* forces the practitioner to reconsider the argument and its components. Practitioners, then, must be able to determine the points at issue, and recognise alternative positions as alternatives. The general model of argumentation supports negative reasoning by allowing the expression of different specific models. In this sense, the operationalisation supports the detection of inconsistencies and ineffectiveness in the construction of requirements via the notion of critique of the requirements argument.

The notion of a ‘critique’ to requirements argument has been interpreted very broadly in the application of the dialectic approach discussed in Chapter 7. This broad interpretation can be understood in two ways:



- as a broad interpretation of the concept of rebuttal
- as a broad interpretation of the notion of critique

These two positions are discussed below.

## 2.2.1 Broad Interpretation of the Concept of Rebuttal

Typically, the notion of a critique to a requirements argument centres on the concept of a rebuttal. However, the application in Chapter 7 suggests that we need to interpret the concept of rebuttal quite broadly. For example, the application suggests that rebuttals may take different forms (e.g. rebuttals that highlight conceptual differences; rebuttals that highlight differences in values; and so on). Furthermore, the application has revealed that rebuttals may be applied to argument elements other than the claim (see also Newman and Marshall, 1991). Both these considerations are discussed below.

### 2.2.1.1. *Different Forms of Rebuttal*

The application of the operationalisation, presented in Chapter 7, has identified a number of different types of rebuttal.

For example, in Requirement #1, we have identified a type of rebuttal that is concerned with *conceptual* differences between the two techniques contributing to the multidisciplinary analysis. That is, the rebuttal highlights a conceptual difference between task ineffectiveness in recording triage information (from the HF perspective), and influences upon human-human communication during triage (from the sociological perspective). In this instance, then, the dialectic approach appears to offer some support towards the accommodation of alternative paradigms, insofar as its ability to support the expression of alternative conceptual positions addresses the criterion:

7) Help practitioners understand alternative beliefs (Burrell and Morgan, 1979);<sup>33</sup>

Similarly, in Requirement #5, we have identified a type of rebuttal that is concerned with the different *values* emphasised by the two techniques contributing to the multidisciplinary analysis. That is, the HF analysis emphasises objective *values* concerning the standardisation of worksystem outputs (e.g. the use of clinical thesauri to code presenting complaints), whilst the sociological analysis emphasises the subjective values of the participants about the nature of the work that they do (e.g. the nurses' emphasis on 'sentimental work', and the need to elicit and record information about the patient's social and emotional state). In this instance, then, the dialectic approach appears to offer some support towards the accommodation of alternative paradigms, insofar as its ability to support the expression of alternative values addresses the criterion:

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<sup>33</sup> Where the concepts held by an individual paradigm constitute the ontological component of that paradigm's particular belief system.



- 8) Help practitioners understand the values and norms of alternative paradigms (Schön, 1983).

In the analysis of Requirement #6, we have identified a type of rebuttal that does not indicate the conditions under which the claim does not hold, but offers a critique of some aspect of the *substance* of the claim (that is, that patients should not be represented by name on a continually presented screen). Clearly, this critique does not alter any other aspect of the claim, and might be thought of as amending the claim without changing its basic form (i.e. that triage data should be collated and displayed for all patients awaiting admittance to a treatment area). The rebuttal helps the practitioner see the relationships between different points of view and the position held by the claim, and modify the claim accordingly. In this instance, then, the dialectic approach appears to offer some support towards the accommodation of alternative paradigms, insofar as its ability to help practitioners modify their views without abandoning them addresses the criterion:

- 14) Support practitioners in the management of commitment and critical reflection (Reinharz, 1981);

Another type of rebuttal that has been identified in the analysis of Requirement #8 is the *context* rebuttal. That is, where the second technique provides a new context within which to view the claim. In the case of Requirement #8, the rebuttal describes the context of computer usage within the hospital hierarchy, and suggests that A&E doctors do not view computer use as a suitable task for a doctor. Another example, of a context rebuttal can be seen in Requirement #1, where it is suggested that nurses are concerned with the public perception of their computer use in the context of patients needing care. In both these examples, it is the very use of the information system in a given context, that is under attack. In this instance, then, the dialectic approach appears to offer some support towards the accommodation of alternative paradigms insofar as its ability to evaluate practical outcomes addresses the criterion:

- 6) Help practitioners understand the practical implications of alternative paradigm positions (Skrtic, 1990);

Note also, that sometimes the additional context information provided by the rebuttal may not adversely affect the claim (see Requirement #14), but may influence the argument structure more generally.

#### 2.2.1.2. *Applying Rebuttals to Other Argument Elements*

Homer-Dixon and Karapin (1989) suggest that rebuttals can point to any argument element within the Toulmin model. This notion is supported by the application reported in Chapter 7, where the need to critique the claim, warrant, and backing were identified, as follows:

- Critique the claim of the RA



According to the original Toulmin model (Toulmin, 1958), the concept of rebuttal is generally understood as the circumstances under which the authority of the warrant would have to be set aside (i.e. it defines exceptions to the rule when the claim does not hold true). However, in the current application, we have noted that the claim may be critiqued directly when new argument elements from the alternative discipline analysis are brought to bear. For example, in Requirement #1, the claim is that: because duplication is ineffective and an electronic version of the triage details is always required, triage nurses should only record triage details electronically. A 'straight-forward' rebuttal might suggest that the authority of the warrant would be set aside, for instance, if 'electronic information storage is inappropriate for reasons of patient privacy (e.g. for patients with HIV)'. However, in Requirement #1, the rebuttal critiques the claim directly (rather than via its warrant), by broadening the scope of the argument to include new information directly relevant to the claim (i.e. that nurses are very worried about the public's perception of their computer use, particularly when patients have to wait a long time to be seen).

Rebuttals of the claim may be particularly important, insofar as they support practitioners in helping to overcome their biases. For instance, when a claim is attacked directly, it forces the practitioner to critically assess their position, and to ask themselves whether they believe in the claim and are prepared to stand by it (i.e. they might ask themselves, do I like what I get when I specify this claim?). In this instance, then, the dialectic approach appears to offer some support towards the accommodation of alternative paradigms, insofar as its ability to support the reflection of the practitioner upon their own position addresses the criterion:

11) Help practitioners change their own behaviour and beliefs (Le Compte, 1990).

*and also:*

14) Support practitioners in the management of commitment and critical reflection (Reinharz, 1981).

- Critique the warrant of the RA

It is also possible to critique the warrant directly. For example, in Requirement #1, the warrant argues that hand-written triage information is redundant, whereas the rebuttal argues that hand-written triage information preserves the nature of the human-human communication process during triage. The rebuttal is, thus, a direct attack on the premises held by the warrant. In this instance, then, the dialectic approach appears to offer some support towards the accommodation of alternative paradigms insofar as its ability to support the expression of alternative conceptual positions addresses the criterion:

7) Help practitioners understand alternative beliefs (Burrell and Morgan, 1979);

- Critique the backing of the RA

It is also possible to critique directly the underlying backing to the argument. For example, in Requirement #4, the fundamental legal obligations of the hospital to accurately report its success, in meeting the criteria embodied within the Patient's Charter, are



challenged. In this case, the very basis of the argument is attacked directly insofar as the rebuttal expresses the logic behind the nurses' refusal to respect such national requirements<sup>34</sup>. Here, the views of the nurses constitute a direct attack on the premises held by the backing. In this instance, then, the dialectic approach appears to offer some support towards the accommodation of alternative paradigms, insofar as its ability to support the expression of alternative views addresses the criterion:

- 3) Help practitioners appreciate the views of those operating in a different paradigm (Austin, 1990).

### 2.2.2 Broad Interpretation of the Notion of Critique

Another consideration that emerges from the application of the dialectic approach discussed in Chapter 7, is that the notion of a critique of the requirements argument should also include the possibility of *support* for argument elements. This notion is particularly pertinent in the case when the Grounded Theory method provides new supporting information for some element of the requirements argument (be it the data, the warrant or the backing).

For example, Requirement #1 provides an example of support being offered to the backing of the requirements argument. In Requirement #1, the backing argues that the workload of triage nurses is high and should be reduced. Workload is a concept familiar in HF which is embedded in the requirements argument. In this instance, however, this concept appears to have much in common with the more subjective notion that triage is a "hell-hole" or a "war-zone," where staff are under considerable pressure. In this case, then, conceptual difficulties between the paradigms are not exhibited. Instead, assuming an informal equivalence of terms, we may draw on this additional data to support the notion that triage nurses have a high workload (and that this workload should indeed be reduced). In this instance, then, the dialectic approach appears to offer some support towards the accommodation of alternative paradigms, insofar as its ability to support the expression of additional types of critique addresses the criterion:

- 5) Help improve communication between practitioners of different paradigms (Guba and Lincoln, 1989)

and also:

- 12) Help practitioners use different vocabularies (Barbour, 1980; Jackson and Carter, 1991)

Similarly, For example, Requirement #12 provides an example of support being offered to the warrant of the requirements argument. In requirement #12, the warrant argues that the timeliness of investigation requests/results has a significant impact on the time the

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<sup>34</sup> As indicated in Chapter 7, national triage targets are now 15 minutes.



patient spends in the department. This argument is supported by information from the Grounded Theory method that suggests that the real-time requesting/presentation of results would improve the scheduling of the 'doubling-up' strategy used during busy periods to free-up treatment cubicles. In this instance, then, the dialectic approach appears to offer some support towards the accommodation of alternative paradigms, insofar as its ability to support the expression of additional types of critique addresses the criterion:

- 5) Help improve communication between practitioners of different paradigms (Guba and Lincoln, 1989)

As we have seen, then, negative reasoning provides the practitioner with an opportunity to try to understand an alternative position and the consequences and implications of its application or adoption. During the process of negative reasoning, practitioners attempt to contradict their understanding, and (if necessary) to change their concepts and assumptions, which is the subject of the next section which addresses positive reasoning.

### **2.3. Assessment of Operationalisation: "Assess the Requirements Argument/Statement of Cogency"**

In Chapter 3, we suggested that the major purpose of positive reasoning is not to justify one's own view or to attack the weaknesses of other views, but to form a connection between them that allows their mutual exploration by all parties (Guba and Lincoln, 1989). The aim of this process is to reach a consensus decision, when that is possible. When such a consensus is not possible, the process, at the very least, exposes and clarifies the several different views and allows the building of an agenda for further research and argumentation. The process might be thought of as successful (even when consensus is not achieved), if all views are given full consideration and new levels of information and sophistication are reached (Mason, 1969).

Positive reasoning, in contrast to negative reasoning, grasps the interconnections between concepts, not just their differences, and helps practitioners to see the larger picture. In the face<sup>of</sup> contradictions, its goal is to resolve differences of opinion and perspective by looking for a new point of view (Eemeren and Grootendorst, 1992; Yadav and Khazanchi, 1992).

The framework for argumentation operationalises positive reasoning, insofar as it allows us to judge the *cogency* of arguments using explicit *criteria*, and supports reasoning about *future actions* (where further action might comprise: acceptance, rejection or synthesis of arguments, modification of claims; or further analysis, for example).

The application of the dialectic approach in Chapter 7 resulted in the modification of 50% of the original requirements. Figure 8.0 summarises the cogency assessments of the RAs for the requirements that have been modified.



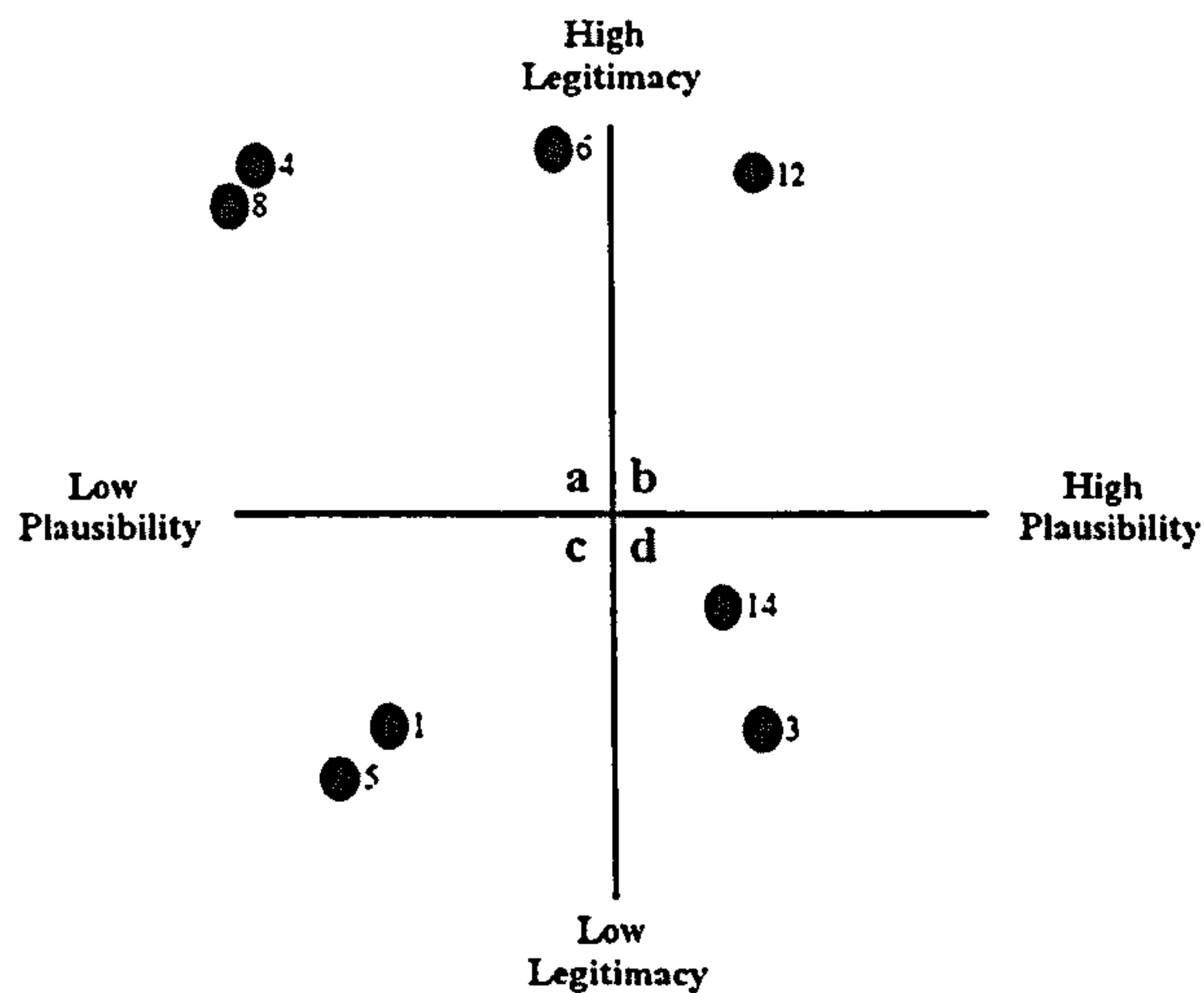


Figure 8.0: Summary of Cogency Assessments of the RAs Modified Via Application of the Dialectic Approach

From Figure 8.0 we can see that: Requirements 4, 6 and 8 were subject to an improvement in their claims (which in the case of Requirement #4 resulted in the reformulation of the requirement based on an improved problem understanding); Requirements 3, and 14 were subject to an improvement in their grounds; and Requirements 1 and 5 were subject to a synthesis of opposing views.

The improvements and modifications to requirements resulted from the following processes:

- transposing argument elements
- developing argument elements
- constructing new requirements around rebuttals

These processes are discussed below.

## 2.4. Transposing Argument Elements

In Requirement #1, a resolution of opposing points of view was constructed by identifying points of agreement, and using such agreements to reformulate the requirements argument by transposing argument elements. Specifically, both methods agreed that triage nurse workload was too high, so the backing to the original requirements argument was converted to a data item and placed in conjunction with the original data item. All three of the other contributions from the Grounded Theory method (i.e. two rebuttals and a data item supporting the backing) were transposed to become warrants. In this instance, then, the dialectic approach appears to offer some support towards the accommodation of alternative paradigms, insofar as its ability to support the reformulation of requirements arguments in the light of the inputs of an alternative paradigm addresses the criterion:

- 5) Help improve communication between practitioners of different paradigms (Guba and Lincoln, 1989)

- 6) Help practitioners understand the practical implications of alternative paradigm positions (Skrtic, 1990).

## 2.5. Developing Argument Elements

Section 2.4 discusses how some argument elements in Requirement #1 were transposed. It is worth noting, however, that in three out of four of these instances it was also necessary to develop the argument element (that is, the argument element could not be transposed as it stood), and it was this development that led to the resolution of alternative positions. For example, Rebuttal (1) was combined with the original warrant to create a new warrant that argues for the importance of both hand-written and electronic triage details. This development led to the reformulation of the claim to suggest that triage nurses should record triage details by hand, whilst other staff should be responsible for recording such details electronically.

The reformulation of the claim led, in turn, to the development of Rebuttal (2) and Data (2) to identify that administrative staff were highly competent computer users, who recognised the pressures upon triage staff and were prepared to help them when required. In this instance, then, the dialectic approach appears to offer some support towards the accommodation of alternative paradigms, insofar as its ability to support the development of argument elements derived from alternative methods addresses the criteria:

- 10) Support practitioners in the conscious articulation of alternative paradigm positions (Crandall, 1990) ;

*and*

- 9) Bring the role of the paradigm into the realm of conscious thought (Schön, 1983).

In the analysis of Requirement #6, we have identified a type of rebuttal that does not indicate the conditions under which the claim does not hold, but offers a critique of some aspect of the *substance* of the claim (that is, that patients should not be represented by name on a continually presented screen). Clearly, this critique does not alter any other aspect of the claim, and might be thought of as amending the claim without changing its basic form (i.e. that triage data should be collated and displayed for all patients awaiting admittance to a treatment area). The rebuttal helps the practitioner see the relationships between different points of view and the position held by the claim, and modify the claim accordingly. In this instance, then, the dialectic approach appears to offer some support towards the accommodation of alternative paradigms, insofar as its ability to help practitioners modify their views without abandoning them addresses the criterion:

- 14) Support practitioners in the management of commitment and critical reflection (Reinharz, 1981);



## 2.6. Constructing new requirements arguments around rebuttals

In Requirement #4, it was suggested that the high workload experienced by triage nurses, and the intense pressure to meet Patient's Charter targets, often leads to the false reporting of triage times, and that the system should, therefore, record triage times automatically. The rebuttal, however, suggested that nurses actually willfully ignore the stipulations of the Charter, because they feel them to compromise patient care. In the light of this enhanced problem understanding, the requirement was completely reformulated. The rebuttal was re-expressed to construct a new data item (that nurses ignored the stipulations of the Charter), and a new requirements argument was constructed from these data. Note that in this case, the requirement was constructed 'forwards' as opposed to backwards, as we indicated earlier. In this instance, then, the dialectic approach appears to offer some support towards the accommodation of alternative paradigms insofar as its ability to support the reformulation of requirements arguments, in the light of the inputs of an alternative paradigm addresses the criterion:

1) Support multiparadigmatic contributions to the same inquiry (Austin, 1990).

and perhaps:

4) Allow each paradigm to express itself independently of the other (Burrell and Morgan, 1979).

Similarly, in Requirement #5, a new requirement was constructed around a powerful rebuttal that suggested that triage nurses attempt to capture all factors relevant to a patient's well-being, rather than just specifying their medical condition. Again, the rebuttal was transposed into the data upon which the new argument was constructed. In this instance, then, the dialectic approach appears to offer some support towards the accommodation of alternative paradigms, insofar as its ability to support the reformulation of requirements arguments in the light of the inputs of an alternative paradigm addresses the criterion:

1) Support multiparadigmatic contributions to the same inquiry (Austin, 1990).

and perhaps:

4) Allow each paradigm to express itself independently of the other (Burrell and Morgan, 1979).

Positive reasoning, then, searches for creative resolutions in the face of conflict, and as such demands a discussion-minded attitude, starting from an increased awareness of one's own conceptual position and the opposition to it (via reflection and negative reasoning). It also demands that we be prepared to clarify and develop our current notions.

For example, in Requirement #4, it was suggested that the high workload suffered by triage nurses, and the intense pressure to meet Patient's Charter targets, often leads to the false reporting of triage times, and that the system should, therefore, record triage times automatically. The rebuttal, however, suggested that nurses actually willfully ignore the

stipulations of the Charter, because they feel them to be incommensurate with their professional judgement. In the light of this enhanced problem understanding, the requirement was reformulated taking the rebuttal as the data for the new requirement. Finally, it is worth noting that not only may the requirements be reconstructed, but the practitioners themselves may reconstruct their own conceptual positions (Gadamer, 1975; Solomon, 1983). For example, positive reasoning may support speculation about personal beliefs. Although, beliefs cannot be immediately switched on and off at will, they are to some extent under our control and may be modified (Geach, 1976).

In sum, if the process of positive reasoning is successful, the dialectic practitioner may have built a new agenda for negotiation, and may have reconstructed the concepts with which he or she began, and in so doing have developed a more informed and sophisticated perspective.

### **3. Summary**

In the above, we have demonstrated that the operationalisation of the dialectic process and its products does seem to have the ability to meet a number of the criteria for the successful accommodation of paradigms proposed in Chapter 2. Table 8.2, indicates which criteria have been addressed by which processes in the operationalisation.



Criteria	Construct RA	Critique RA	Assess Cogency	Totals
<b>A. Criteria for the social-community accommodation of paradigms</b>				
1) Support multiparadigmatic contributions to the same inquiry.			•	1
2) Help practitioners understand the key issues of each paradigm.				
3) Help practitioners appreciate the views of those operating in a different paradigms.		•		1
4) Allow each paradigm to express itself independently of the other.			••	2
5) Help improve communication between practitioners of different paradigms.		•••	•	4
6) Help practitioners understand the practical implications of alternative paradigm positions .		•	•	2
7) Help practitioners understand alternative beliefs.		••		2
8) Help practitioners understand the values and norms of alternative paradigms.		•		1
<b>Sub-Totals</b>	0	8	5	<b>13</b>
<b>B. Criteria for the individual accommodation of paradigms</b>				
9) Bring the role of the paradigm into the realm of conscious thought.			•	1
10) Support practitioners in the conscious articulation of alternative paradigm positions.			•	1
11) Help practitioners change their own behaviour and beliefs.		•	••	3
12) Help practitioners use different vocabularies.		•		1
13) Support practitioners in the enumeration of specific paradigm positions and criticisms.	•			1
14) Support practitioners in the management of commitment and critical reflection.		••	•	3
<b>Sub-Totals</b>	1	4	5	<b>10</b>
<b>Totals</b>	1	12	10	<b>23</b>

Table 8.2: Criteria Addressed by the Operationalisation



From Table 8.2, we can make a number of comments about the way in which the operationalisation has addressed the criteria for the accommodation of paradigms.

First, from the point of view of coverage, thirteen of the fourteen criteria (93%) have been addressed at least once by the operationalisation (and many have been addressed a number of times). This fact is encouraging insofar as the operationalisation addresses the majority of the criteria at least to some extent. However, the operationalisation does not explicitly *help practitioners understand the key issues of each paradigm* (Criterion 2) - since in practice this would rely upon detailed descriptions of the concepts held by a particular paradigm - descriptions which the dialectic approach does not currently provide.

Second, the relative coverage between criteria concerned with either the social community or the individual accommodation of paradigms is fairly even, with social community accommodation being addressed thirteen times (57%), and individual accommodation being addressed ten times (43%). Again, this fact is encouraging with respect to the breadth of concerns addressed by the operationalisation.

Third, the number of criteria addressed by the different phases of the operationalisation (i.e. construction, criticism, and assessment of cogency) varies quite markedly, with construction only addressing one criterion (8%), criticism addressing 12 criteria (86%), and assessment addressing ten criteria (71%). These figures are not unsurprising, perhaps, insofar as the construction of the requirements argument calls for reasoning only within a single discipline. Again, however, the large number of criteria addressed during criticism and assessment are encouraging insofar as such coverage is likely to support the accommodation of alternative paradigms and hence help overcome the problems of multidisciplinary practice (see Chapter 1).

To summarise, then, so far, we have assessed the ability of the operationalisation of the dialectic process and its products to support the accommodation of alternative paradigms (and hence support multidisciplinary practice by practitioner) by assessing the extent to which the operationalisation of the approach can satisfy the criteria for support proposed in Chapter 2. However, in the course of the assessment and discussion, we have raised a number of issues which are used in the next section to reconceptualise the dialectic process and its products.

## **4. Reconceptualising the Dialectic Process and Its Products**

In this section, the assessment of the operationalisation described in Sections 2 and 3 is used as the basis from which to reconceptualise the dialectic process and its products. The aim of the reconceptualisation is to enhance the dialectic approach in the light of its application and assessment.



More particularly, in Chapter 3, we developed a specific conceptualisation of the dialectic process and its associated products. This section reconceptualises this specific conceptualisation in the light of the discussions in Section 3.

For convenience, this specific conceptualisation of the dialectic process and its associated products is shown again below (for further details see Chapter 3).

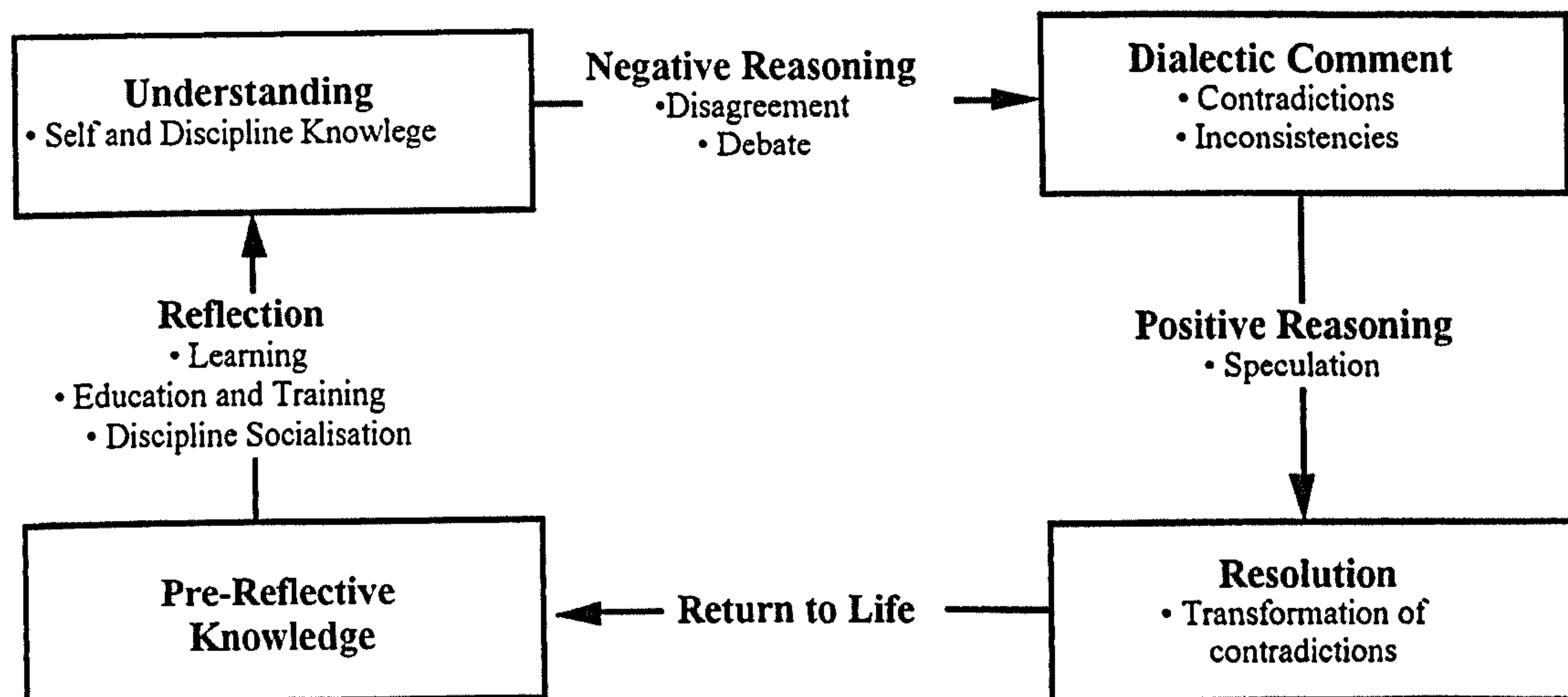


Figure 8.1: Specific Conceptualisation of the Dialectic Process and its Products

The reconceptualisation that follows is particularly concerned with reformulating the dialectic processes and products that are used, and also when these are applied.

## 4.1. Reconceptualising Reflection and Understanding

In Chapter 3, we suggested that the process of **reflection** includes the development of self knowledge and discipline knowledge through education, training, and discipline socialisation, leading to a more informed state known as **understanding** (the state in which an individual can take part in the theory and practice which characterise his or her discipline).

This section uses the assessment of the dialectic operationalisation to reconceptualise the process of reflection and its product (that is, understanding).

### 4.1.1 Reconceptualising Reflection

As indicated in Section 2.1, the search for implicit/absent logic to the reasoning behind requirements, makes practitioners aware of the way that he or she has framed the requirements problem, and alerts them to the possibility of alternative ways of framing it. Schön (1983) has suggested that such *reflection-in-action*<sup>35</sup> can serve as a corrective to

<sup>35</sup> Reflection-in-action can be contrasted with reflection-on-action which typically takes place when a particular 'project' has been completed (Schön, 1983).



learning as it allows the practitioner to explore implicit understandings, which can then be criticised, restructured, and embodied in future practice. Reflection-in-action, then, can supplement learning, education and training, and discipline socialisation in the development of self-knowledge and discipline knowledge.

#### 4.1.2 Reconceptualising Understanding

The assessment of the operationalisation described in Section 2, however, has also revealed a number of components of such self and discipline knowledge that are pertinent to the construction of requirements arguments. Here, these components have been grouped into the following categories:

*i) Nature of requirements (technique):* this component of the reconceptualisation is concerned with the sort of requirements addressed by the selected technique. In this regard, the dialectic approach should support practitioners in identifying whether the selected requirements technique is concerned with technical requirements, social requirements, organisational requirements, and so on. Consideration should also be given to how the scope of the selected technique manifests itself in the data, warrant and claim of the requirements argument that has been constructed. It is also important to consider under what conditions the selected technique may be a good one to use, and under what conditions it may be a bad one, and to examine its main advantages and disadvantages.

*ii) Nature of requirements (practitioner):* this component of the reconceptualisation is concerned with the assumptions held about requirements by the practitioner. In this regard, the dialectic approach should support practitioners in identifying to what sort of requirements they have given priority, what sort of requirements they have given less importance, and what sort of requirements they have left out altogether. Consideration should also be given to how these concerns are reflected in the construction of the requirements argument, and the limitations of the practitioner's views.

*iii) Concepts (technique):* this component of the reconceptualisation is concerned with the underlying concepts embedded in the selected technique. In this regard, the dialectic approach should support practitioners in identifying how these concepts manifest themselves in the data, warrant and claim of the requirements argument that they constructed.

*iv) Concepts (practitioner):* this component of the reconceptualisation is concerned with the underlying concepts embedded in the analytic style of the practitioner. In this regard, the dialectic approach should support practitioners in identifying how these concepts manifest themselves in the data, warrant and claim of the requirements argument they have constructed.

*vi) Values (technique):* this component of the reconceptualisation is concerned with the underlying values embedded in the selected technique. In this regard, the dialectic approach



should support practitioners in identifying how have these values manifest themselves in the data, warrant and claim of the requirements argument they have constructed.

vii) *Values (practitioner)*: this component of the reconceptualisation is concerned with the underlying values embedded in the analytic style of the practitioner. In this regard, the dialectic approach should support practitioners in identifying how these concepts manifest themselves in the data, warrant and claim of the requirements argument they have constructed.

viii) *Background knowledge*: this component of the reconceptualisation is concerned with the background knowledge that is taken for granted in the requirements argument. In this regard, the dialectic approach should support practitioners in identifying, for example, what concepts are left unexplained. Practitioners might ask themselves, what would a completely novice reader need to know in order to understand the requirements argument constructed from the outputs of this technique.

### 4.1.3 Reconceptualising the Timing of Reflection

Next we need to consider *when* to apply reflection to the requirements argument. Table 8.3 maps reflection as described in Chapter 3 to its operationalisation as applied in Chapter 7.


Procedure	Reflection
1. Construct a requirements argument (express output from MUSE in terms of model, e.g. data, warrant, background and claim).	
2. Critique the requirements argument using outputs of Grounded Theory method.	
3. Assess cogency of the requirements argument in light of critique, and act on this assessment.	

Table 8.3: Original Conceptualisation of When Reflection Takes Place

However, as a result of the application of the dialectic approach, this expression of the timing of reflection is somewhat limited (particularly given our discussion of reflection in action - see Section 4.1.1). For example, during the application in Chapter 7, the critique of the requirements argument acted as a catalyst for reflection on both techniques and the relationship between them. That is, the expression of a rebuttal forces consideration of the underlying features of the argument to which the rebuttal applies. In this sense, the critique not only challenged existing concepts, but also forced the practitioner to re-examine those concepts. For example, the recognition of conceptual differences between the MUSE analysis and the Grounded Theory method forces the practitioner to explore in more detail both the original concept and the alternative concept (and any relationship between them) in



order to reason about the nature of such differences. Also, in the case of rebuttals addressing the context of the requirements argument, the recognition of the need to develop or clarify argument elements forces the practitioner to make more explicit the assumptions on which the original argument was based. Similarly, as a result of assessing the cogency of a requirement, the transposing of argument elements may lead to the construction of a new requirements argument and the possibility of further reflection.

The above examples illustrate that reflection is an on-going process that takes place throughout the application of the dialectic approach. The analyst, however, is not always reflecting on the same things. For instance, whilst considering the critique of a requirements argument, the analyst will be reflecting in particular on Technique 1 from which he is constructing the RA. In contrast, following the assessment of cogency of a requirements argument, the practitioner may be reflecting on both Technique 1 and Technique 2 (and indeed on the relationship between them). Table 8.4, illustrates the on-going nature of reflection with respect to the operationalisation used in Chapter 7.




Procedure	Reflection
1. Construct a requirements argument (express output from MUSE in terms of model, e.g. data, warrant, background and claim).	
2. Critique the requirements argument using outputs of Grounded Theory method.	
3. Assess cogency of the requirements argument in light of critique, and act on this assessment.	

Table 8.4: Re-Conceptualisation of When Reflection Takes Place

## 4.2. Reconceptualising Negative Reasoning and Dialectic Comment

In Chapter 3, we suggested that **negative reasoning** stretches our concepts to the limit by forcing contradictions from them and pressing contradictions upon them (Bhaskar, 1994). Negative reasoning is characterised by the construction of the strongest possible debate or disagreement on a given issue (Mitroff, 1970). The end point of the process of negative reasoning results in a **dialectic comment** on the practice of the pre-existing community which reveals and exposes its inadequacies and inconsistencies.

This section uses the assessment of the dialectic operationalisation to reconceptualise the process of negative reasoning and its product (that is, dialectic comment).



### 4.2.1 Reconceptualising Negative Reasoning

The assessment of the operationalisation described in Section 2, however, reveals a number of components of the process of negative reasoning that are pertinent to the construction of requirements arguments. Here, these components have been grouped into the following categories:

- i) *Debate/disagreement on concepts*: where the rebuttal highlights a conceptual difference between the outputs of the two requirements engineering techniques.
- ii) *Debate/disagreement on values*: where the rebuttal highlights differences in the values embodied by the outputs of the two requirements engineering techniques.
- iii) *Debate/disagreement on substance*: where the rebuttal provides a critique of some aspect of the substance of the requirements argument.
- iv) *Debate/disagreement on context*: where the rebuttal provides a new context within which to view the requirements argument.

### 4.2.2 Reconceptualising Dialectic Comment

The assessment of the operationalisation, described in Section 2, has also revealed a number of different types of conflict and contradiction. Here, these types have been grouped into the following categories:

- i) *Oppositional comment*: an expression of some totally contradictory position to that stated in the requirements argument.
- ii) *Conditional comment*: an expression of doubt that identifies conditions under which one of the argument elements may not hold.
- iii) *Contextual comment*: an expression of doubt that an argument element is appropriate in the current context.
- iv) *Clarifying comment*: an expression of doubt that identifies some inadequacy in the requirements argument that requires further explanation/explication.
- v) *Supporting comment*: an expression that adds weight to a given argument element.

### 4.2.3 Reconceptualising the Timing of Negative Reasoning

With respect to *when* to apply the process of negative reasoning to the requirements argument, there was no evidence from the application discussed in Chapter 7 that negative reasoning is applied outside the critique phase of the operationalisation.

## 4.3. Reconceptualising Positive Reasoning and Resolution

In Chapter 3, we characterised positive reasoning as creative speculation leading to the expansion of an existing conceptual field. Speculation is the act of attempting to free oneself from one's subjective views, interests, and biases in order to work through the conflicting



elements identified in negative reasoning (Hodgson, 1993). Expansion of the existing conceptual field (or world view), through positive reasoning, results in the transformation of contradictions that leads ultimately to a resolution of the conflict (Cosier et al, 1978). Resolution is characterised by the incorporation of contradictions into a fuller, richer, more comprehensive understanding.

This section uses the assessment of the dialectic operationalisation to reconceptualise the process of positive reasoning and its product (that is, resolution).

### 4.3.1 Reconceptualising Positive Reasoning

The assessment of the operationalisation, described in Section 2, has also identified that speculation can be characterised as comprising the following processes:

i) *Agreement between techniques*: where practitioners seek to identify common ground between the outputs of the two techniques.

ii) *Development of requirements arguments*: where practitioners seek to clarify and develop their current notions.

iii) *Acceptance of significant rebuttals*: where practitioners seek to acknowledge the strength of a rebuttal without prejudice.

iv) *Mediation of alternatives*: where practitioners adopt a discussion-minded attitude, and consider alternative information in an open and non-judgmental manner.

### 4.3.2 Reconceptualising Resolution

The assessment of the operationalisation described in Section 2, however, reveals a number of components of the product of positive reasoning (that is, resolution) that resulted in improvements and modifications to requirements arguments. Here, these processes have been grouped into the following categories:

i) *Transposition and reconstruction of requirements arguments*: where, having identified common ground between the outputs of the two techniques (see Section 2.4), practitioners ‘rearrange’ the argument elements to reconstruct the requirements argument around these points of agreement.

ii) *Combination, addition, and reformulation of requirements argument elements* where, having identified the need for the development of a requirements argument (see Section 2.5), practitioners combine one argument element with another. Practitioners may also add to, or reformulate, information within an argument element.

iii) *Construction of new requirements arguments*: where, having identified the strength of a rebuttal (see Section 2.6), practitioners construct a wholly new requirement to take into account its critique.



### 4.3.3 Reconceptualising the Timing of Positive Reasoning

With respect to *when* to apply the process of positive reasoning to the requirements argument, there was no evidence from the application discussed in Chapter 7 that positive reasoning is applied outwith the assessment of cogency of the operationalisation.

### 4.4. Summary of the Reconceptualisation

In this section, we have used the assessment of the operationalisation described in Sections 2 and 3 as the basis from which to reconceptualise the dialectic process and its products. The aim of the reconceptualisation is to enhance the dialectic approach in the light of its application and assessment, and to provide an amended specific conceptualisation of the dialectic process and its products from which further developments of the dialectic approach may proceed. The amended specific conceptualisation is summarised in Figure 8.2 below:

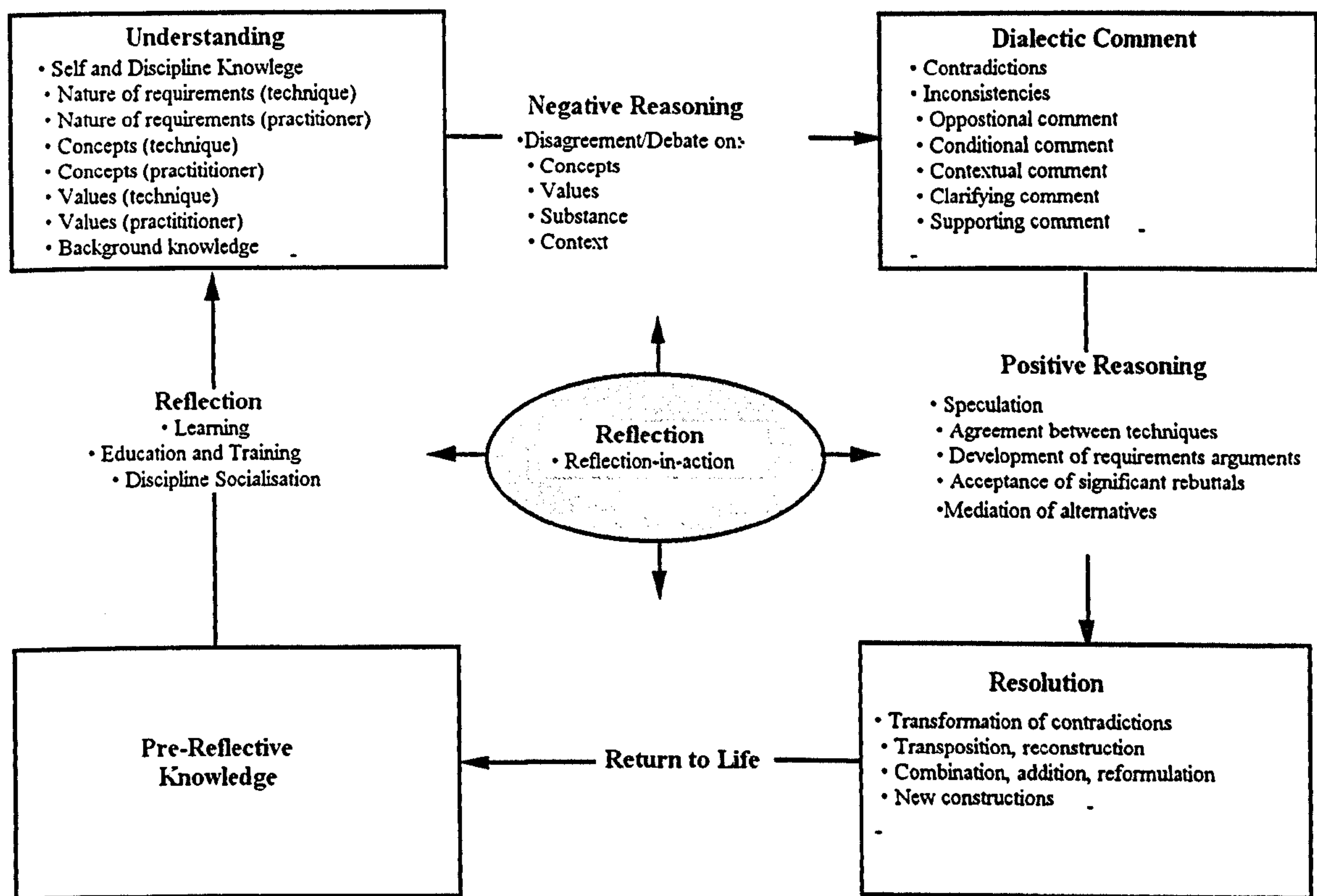


Figure 8.2: Amended Specific Conceptualisation  
of the Dialectic Process and its Products

The strategy described above has been employed as a means to develop and enhance the dialectic approach through application to a real-world case study. The outputs of this strategy might be thought of as constituting the first stages in the development of a dialectic

*method* insofar as it has proposed a dialectic approach, informally assessed this approach in the context of a real-world case study, and proposed an enhanced version of the approach. The development of a dialectic method *per se* would require many such cycles of iteration and test (and validation), and would require considerable resources (and is hence beyond the scope of this thesis).

## 5. Limitations of the Research, and Suggestions for Future Work

This section identifies the limitations of the research embodied in this thesis, and suggests possibilities for future work. More particularly, we consider limitations in:

- the development of the dialectic approach
- the application and assessment of the dialectic approach

### 5.1. Limitations in the Development of the Dialectic Approach

The development of the dialectic approach as described in this thesis has a number of limitations that are discussed below.

#### 5.1.1 Limitations with respect to the Specification of the Problem Space

With respect to the development of the dialectic approach, it was necessary to devote considerable time and space to developing an understanding of the ‘problem space’, including:

- developing an understanding of requirements engineering and its multidisciplinary nature
- developing an understanding of alternative paradigms and the possibility of their practical accommodation

Some limitations of the thesis with respect to these two issues are discussed below.

##### 5.1.1.1. *Multidisciplinary Practice is Poorly Understood*

The first limitation in the development of the dialectic approach is that there are few studies that outline the *problems* of multidisciplinary practice, and that the *requirements* for support for multidisciplinary practice are poorly specified.

For instance, there is little in the literature to provide a theoretical address of multidisciplinary practice in general, or multidisciplinary requirements engineering in particular, and (as indicated in Chapter 1), there are few case studies of multidisciplinary practice (again, either in general or with particular reference to requirements engineering). This means that the specification of the problem space is largely based on the author’s own views with evidence extracted from the literature as appropriate. Clearly, a more consensus



view on the problems of multidisciplinary practice in requirements engineering would provide firmer grounds from which to develop appropriate support.

Future work, then, might seek to develop such a consensus view on the problems of multidisciplinary practice in requirements engineering by conducting practitioner surveys, undertaking more comprehensive studies of multidisciplinary design practice, and so on.

#### 5.1.1.2. *Paradigm Controversies*

In Chapter 2, we explained the problems of multidisciplinary practice in terms of the incommensurability of paradigms, and proposed that multidisciplinary practice was only possible if we accepted the possibility of the practical accommodation of alternative paradigms. From the discussions in Chapter 2, it is clear that neither of these positions is free from controversy. Indeed, in many ways the arguments in this thesis lie between a rock and a hard place. On the one hand, for those who do not believe in the incommensurability of paradigms (see the discussion on postmodernism in Chapter 2), the need for any support to overcome such problems may well be deemed unnecessary. But on the other hand, for those who do believe in the incommensurability of paradigms, the very idea of accommodating alternative paradigms may be considered (at best) difficult, or (at worst) logically impossible.

#### 5.1.2 Limitations in the Form of the Dialectic Approach

Notwithstanding the effort required to develop the problem space, the development of the ‘solution space’ (that is, the dialectic approach itself) also involved the ‘breadth-first’ explication of a considerable amount of conceptual/theoretical background into the nature of dialectic reasoning and argumentation (see Chapter 3).

As a result of such efforts, and given the limitations of an individual project of doctoral research, the development of the dialectic approach has been restricted to a fairly high level of description. This high level of description, in turn, leads to a number of limitations in the form of the approach *per se*. For example, the dialectic approach lacks detail on the methodological and substantive knowledge to be employed.

More particularly, the dialectic approach as described in this thesis takes a ‘breadth-first’ approach to offering support for multidisciplinary practice. That is, the dialectic approach addresses: reflection (constructing the requirements argument); negative reasoning (critiquing the requirements argument); positive reasoning (assessing requirements arguments and acting on this assessment); understanding (specifying data, claims and warrants), dialectic comment (specifying rebuttals and qualifiers); and resolution (stating the cogency of requirements arguments). Ideally, each of these concerns should be supported with explicit and well-defined procedures that indicate the steps to be taken, the manner in which information should be represented, hints and tips for applying the approach and so on.



Future work, then, might address the more detailed development of the dialectic approach, including consideration of:

- procedures and notations (for both the dialectic process and its operationalisation)
- functionality and usability assessments of the approach
- assessment of the costs and benefits of the application of the approach
- tool support

## **5.2. Limitations in the Application and Assessment of the Dialectic Approach**

Because of the 'breadth first' strategy adopted in the development and enhancement of the dialectic approach, the approach itself has only been applied and assessed informally. Limitations in both the application and assessment of the method are discussed below.

### **5.2.1 Limitations in the Application**

There are a number of limitations with respect to the application of the dialectic approach. These are discussed below.

#### *5.2.1.1. Preparation to Apply the Dialectic Approach*

With respect to the application of the dialectic approach, it was necessary to devote considerable time and space in preparing to apply the approach; that is, was necessary first to:

- explicate, configure, and apply the MUSE method in the domain of accident and emergency healthcare
- explicate, configure, and apply the Grounded Theory method in the domain of accident and emergency healthcare

For example, Chapters 5 and 6, used the MUSE method and the Grounded Theory method respectively to analyse the domain of accident and emergency healthcare to construct requirements for the redesign of the A&E information system. Both these methods required considerable explication, and MUSE in particular required specific configuration prior to its application. However, the application of both of these methods was a prerequisite for the application of the dialectic approach.

#### *5.2.1.2. Simulating Multidisciplinary Practice*

As discussed above, the author was responsible for applying both the MUSE method and the Grounded Theory method, and consequently the application of the dialectic approach itself is effectively predicated on a simulation of dependent multidisciplinary practice by



practitioner. That is, the development of the approach has addressed the collaboration between an human factors practitioner and a social science practitioner in the field of requirements engineering, where the author plays the role of both the human factors practitioner and the social science practitioner. In each role, then, it is the author who acts as a channel for the respective discipline knowledge. Although the author had some background in the second discipline (i.e. sociology), and also placed considerable emphasis on understanding its paradigm underpinnings to simulate the sort of responses to specific concerns that are raised by the use of his primary discipline (i.e. human factors), this approach clearly has its limitations and potential for individual bias. In general, however, the need for simulation was unavoidable because the dialectic approach is still in the very earliest stages of its development by the author, and could not have been applied by anyone other than the author within the resourcing constraints of an individual doctoral research project.

#### *5.2.1.3. Neutral Data Collection?*

Again, as mentioned above, the application of the dialectic approach required the author to perform the role of 'analyst' using both the MUSE method and the Grounded Theory method. However, to avoid 'method' bias, it was important that data were collected in as 'neutral' a manner as possible<sup>36</sup>. That is, data were collected prior to any analysis, and were not tailored to any one particular technique.

To summarise the data collection process, twelve hours of unstructured interviews were recorded and transcribed, and the author also observed the normal activities of the department during some or all of the three nursing shifts ('early' 7am to 3pm, late 1.30pm to 9.30pm, and 'night' 9pm to 8am). Field notes were taken during the observations, and where possible, on the job conversations with staff were entered into. Informal conversations in the staff room were also entered into. (For more details of the data collection process, see Chapter 3).

This data collection process has two limitations. First, there is no guarantee as to the degree of 'neutrality' maintained. For example, the author evidently comes to the study with his own set of personal biases, viewpoints and discipline influences. Second, and perhaps more importantly, attempting to maintain neutrality means that neither the MUSE method or the Grounded Theory method starts with data that are tailored to their respective needs. For example, the Grounded Theory method is typically based upon iterative cycles of data collection that are shaped by both the researcher's own constructions and those of other participants.

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<sup>36</sup> Note that 'neutral' in this context does not equate with 'objective', as commonly understood in the positive and post-positive paradigms.

## 5.2.2 Limitations in the Assessment

There are a number of limitations with respect to the assessment of the dialectic approach. These are discussed below.

### 5.2.2.1. *Informal 'Breadth-First' Assessment*

The assessment of the dialectic approach performed here is largely informal, and focuses on a demonstration of the feasibility of the dialectic approach. Where a demonstration of feasibility is taken to comprise:

- coherent application of the dialectic approach (including the construction of new requirements, and the clear exposition of the steps taken)
- clear interpretation of the dialectic approach during its application
- assessment of the dialectic approach against pre-determined criteria
- consideration of the extent to which stated problems in RE are addressed and alleviated

Essentially, then, the case study demonstrates feasibility, insofar as it affords the reader an opportunity to look for coherence in the process that constitutes the case study and its reporting.

There are a number of problems with this approach. First, we have carried out a single case study, addressing a large and complicated worksystem, in a complex domain. This approach was chosen in order to best simulate 'real world' multidisciplinary practice, but given the early stages of development of the dialectic approach, it may have been more prudent to conduct a number of cycles of application and test using smaller scale worksystems and much less complex domains. Second, as described in Chapter 7, we have relied upon an indirect endorsement of the products of the dialectic approach (via the system developers), rather than a direct assessment of the design products to show their superiority over products created without the use of the method.

Future work might address the development of the method in the context of more rigorous assessments, and might include:

- 'depth first' studies of particular aspects of the dialectic approach under 'laboratory' conditions
- 'depth first' studies of particular aspects of the dialectic approach in the field

These 'depth-first' studies might also be complemented by further 'breadth first' studies, including:

- further studies by the author in different domains
- follow-up studies by other researchers



- field studies with individual designers
- field studies with design teams, etc.

It should be noted that an important element in the development and assessment of the dialectic approach (with respect to each of the above points) would be its general suitability with respect to the RE techniques that it can accommodate.

## 6. Summary

This thesis has attempted to develop an approach that supports dependent multidisciplinary practice in requirements engineering. To summarise, we have argued that multidisciplinary requirements engineering practice is ineffective, and identified some specific problems for dependent multidisciplinary practice. We have also suggested that the incommensurability of conflicting paradigms is an underlying cause of the problems in dependent multidisciplinary practice, and proposed a number of criteria for support to overcome such problems. A form of methodological support, which it is claimed may help overcome some of the problems associated with dependent multidisciplinary practice in requirements engineering, was developed. This methodological support takes the form of a dialectic process, and its associated products, which was conceptualised and then operationalised. The operationalisation of the dialectic process was applied to requirements generated by the use of two alternative techniques (MUSE and Grounded Theory method), and this application illustrated the methodological support it offers to multidisciplinary practice. Finally, we have assessed the application of the operationalisation of the dialectic process with respect to the criteria for support for multidisciplinary practice proposed earlier, and used this assessment to reconceptualise the dialectic process. The limitations of the research were identified, and possibilities for future work proposed.

This thesis is aimed primarily at the requirements engineering community, and in particular the practising requirements engineer. The thesis has made two contributions to knowledge supporting the practices of requirements engineering.

First, the thesis has contributed two types of *substantive* discipline knowledge, these are:

i) an explanation of why multidisciplinary practice in requirements engineering is problematic (because of paradigm incommensurability). It is envisaged that this explanation will help requirements engineering practitioners acquire a new understanding of their own practices, make the practitioners more reflective about their own beliefs, and be more willing to be as critical of their own beliefs and opinions as they may be about the arguments that challenge them.

ii) the proposal of criteria for support to allay the difficulties of multidisciplinary practice (by means of the practical accommodation of paradigms). The criteria might be used in the *development* of new types of support to overcome such difficulties. The dialectic approach developed in the thesis is one example of such support, but does not preclude the possibility

of other forms. The criteria might also be used in the *assessment* of new requirements engineering techniques (developed by other researchers) that claim to address multidisciplinary practice.

Second, the thesis has contributed *methodological* knowledge in the form of a dialectic approach (that is, a dialectic process and its associated products) that offers a new way of reasoning about requirements engineering. This methodological knowledge takes two forms:

i) a *generic* dialectic approach that might be used by requirements engineering practitioners to overcome the problems of multidisciplinary practice by supporting the practical accommodation of different paradigms. This thesis has illustrated informally the feasibility of the dialectic approach by applying it to requirements generated by the MUSE method and the Grounded Theory method, but this application in no way precludes the possibility that other practitioners might apply the dialectic approach to requirements generated by other techniques (e.g. ethnography and systems analysis).

ii) a *specific instantiation* of the dialectic approach using the MUSE method and the Grounded Theory method that might be used in its current form (or an enhanced form) by requirements engineering practitioners to support their own multidisciplinary practice. This thesis has applied this specific instantiation of the dialectic approach in the domain of Accident and Emergency healthcare, but this application in no way precludes the possibility that the specific instantiation could be used in other domains (or other requirements within the same domain).



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# Appendix 1: Sample Triage Slip from the A&E Department

During triage, an assessment of the patient’s condition is made by the triage nurse, and the details recorded by hand on a triage slip which is given to the patient who then takes the slip to the reception desk to register. An example triage slip is provided below.

NAME			Time Before Triage
AREA	PRIORITY	TIME	SIG.
COMPLAINT			

# Appendix 2: Sample Casualty Card (CAS Card) from the A&E Department

When a patient registers in the A&E department, a Casualty Card (known simply as the ‘CAS Card’) is printed with the patient’s demographic and triage details. The CAS card then accompanies the patient through the department, and details of any further examinations, diagnoses, tests, treatments and notes are either written directly onto the card or attached to it. An example CAS Card is provided overpage.



A

## AINTREE HOSPITALS NHS TRUST A.E.D.

FAZAKERLEY HOSPITAL, LOWER LANE, LIVERPOOL L9 7AL. Tel: 0151-529 2500

SURNAME				FORENAMES				A.E.D. no.	
DATE OF BIRTH	AGE	DATE AND TIME OF ARRIVAL		CIVIL STATE	SEX	RELIGION	OCCUPATION		
ADDRESS				NEXT OF KIN ADDRESS					
				TEL					
TEL				ACCOMPANIED BY:					
TEMP. ADD									
G.P. NAME				ADDRESS				TEL	CODE
MODE OF ARRIVAL				FOLLOWING INCIDENT AT:				TIME	REFRESHMENTS
NAMED NURSE 1				2					
				RELS WITH <input type="checkbox"/>				INFORMED <input type="checkbox"/>	
				NOT INFORMED <input type="checkbox"/>				UNABLE TO CONTACT <input type="checkbox"/>	
				SOCIAL SERVICES					
RADIOGRAPHER			ROOM						
kV	mAs	FILM SIZE	REASON FOR REJECTION	D/N AT HOME					
				AMB	TIME	SIG.	TYPE	MOBILITY AT HOME	
								O <sub>2</sub> Y <input type="checkbox"/> N <input type="checkbox"/>	
								MONITOR Y <input type="checkbox"/> N <input type="checkbox"/>	
			DENTURES	VALUABLES					
FIT FOR DISCHARGE		DISCHARGE TIME	WARD	CONSULTANT				UNIT NUMBER	
TIME									
NURSE DISPOSAL SIG.		BED BOOKED BY:			WITH			TIME	AGREED TIME
PLEASE WRITE LEGIBLY IN CAPITAL LETTERS: PRESENTING COMPLAINT:									
DIAGNOSIS:									
TREATMENT ON DISPOSAL: PRESCRIBED:								<input type="checkbox"/> TREATMENT GIVEN <input type="checkbox"/> DRUGS/PRES. GIVEN <input type="checkbox"/> INSTRUCTIONS GIVEN <input type="checkbox"/> CRUTCHES DUE BACK <input type="checkbox"/> APPT. GIVEN SIG TIME	
INSTRUCTIONS TO G.P. LETTER TO G.P. Y <input type="checkbox"/> N <input type="checkbox"/>									
X-RAY CHECK: AGREED Y <input type="checkbox"/> N <input type="checkbox"/>			FILM REQ.	FILE	T.C.A.	T.C.A. INSTRUCTIONS. NONE <input type="checkbox"/>		SIG	
CODER									

[illegible]



# Appendix 3: Menuflow Diagrams for the Existing A&E Healthcare Information System

The following menuflow diagrams (taken from a user manual) list available options within the existing A&E system.

APPENDIX A - MENUFLOW DIAGRAMS

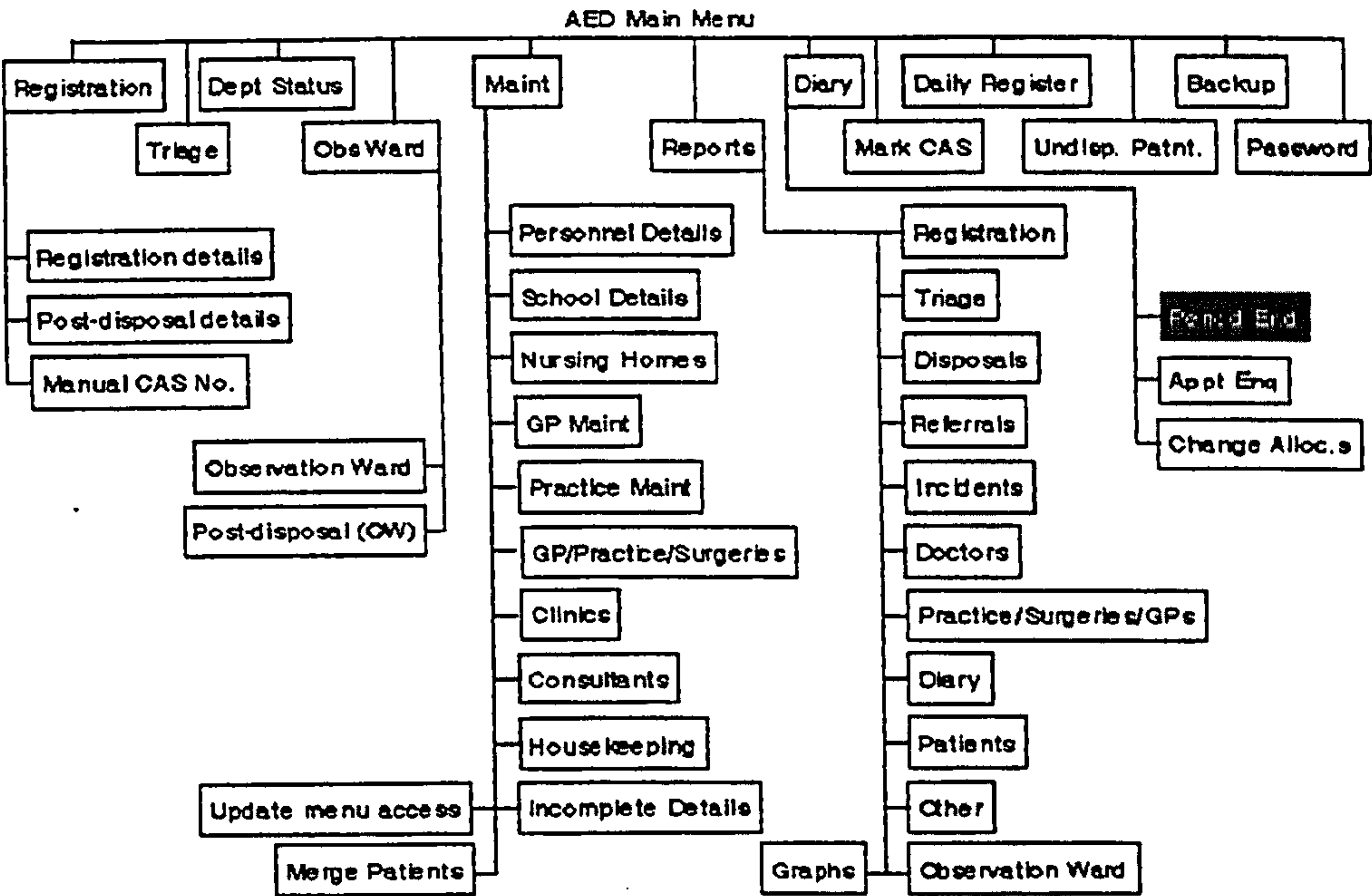
Standard

Manager

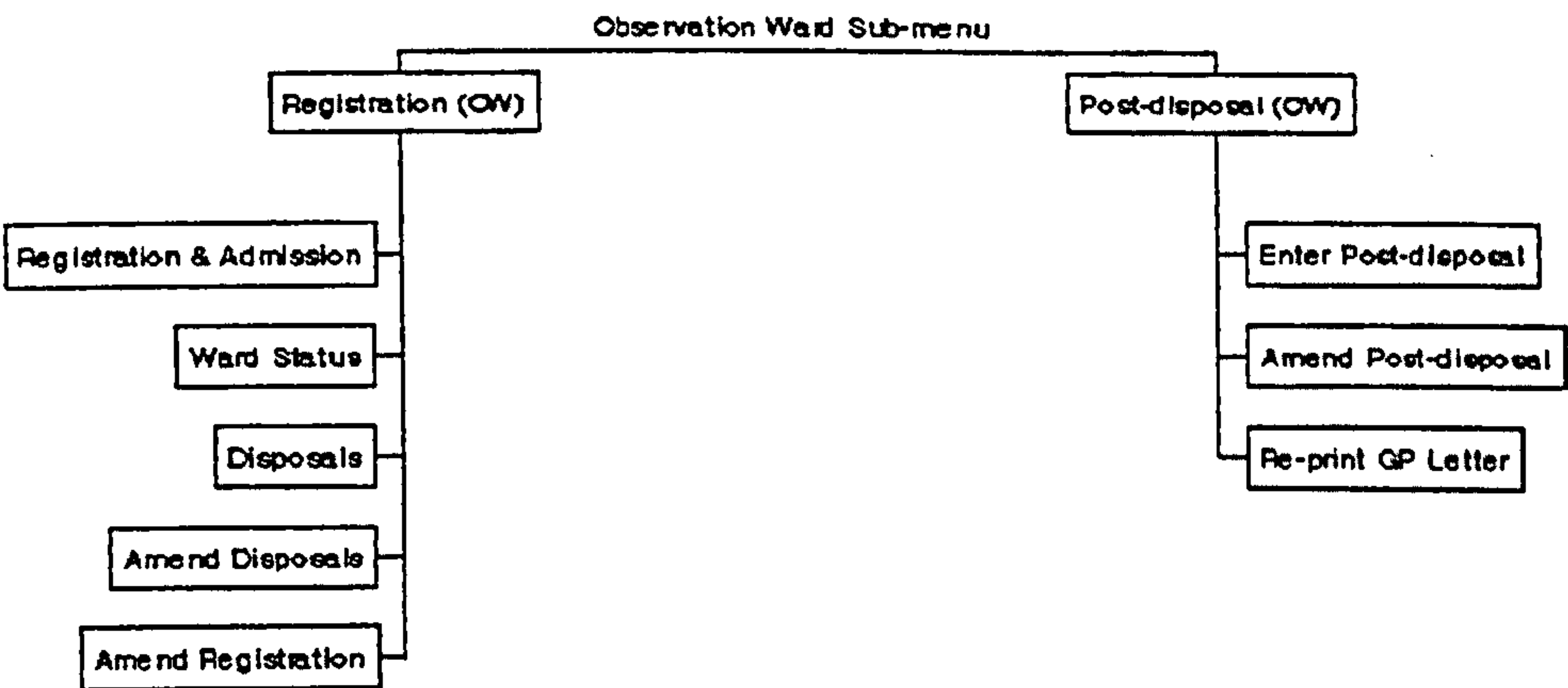
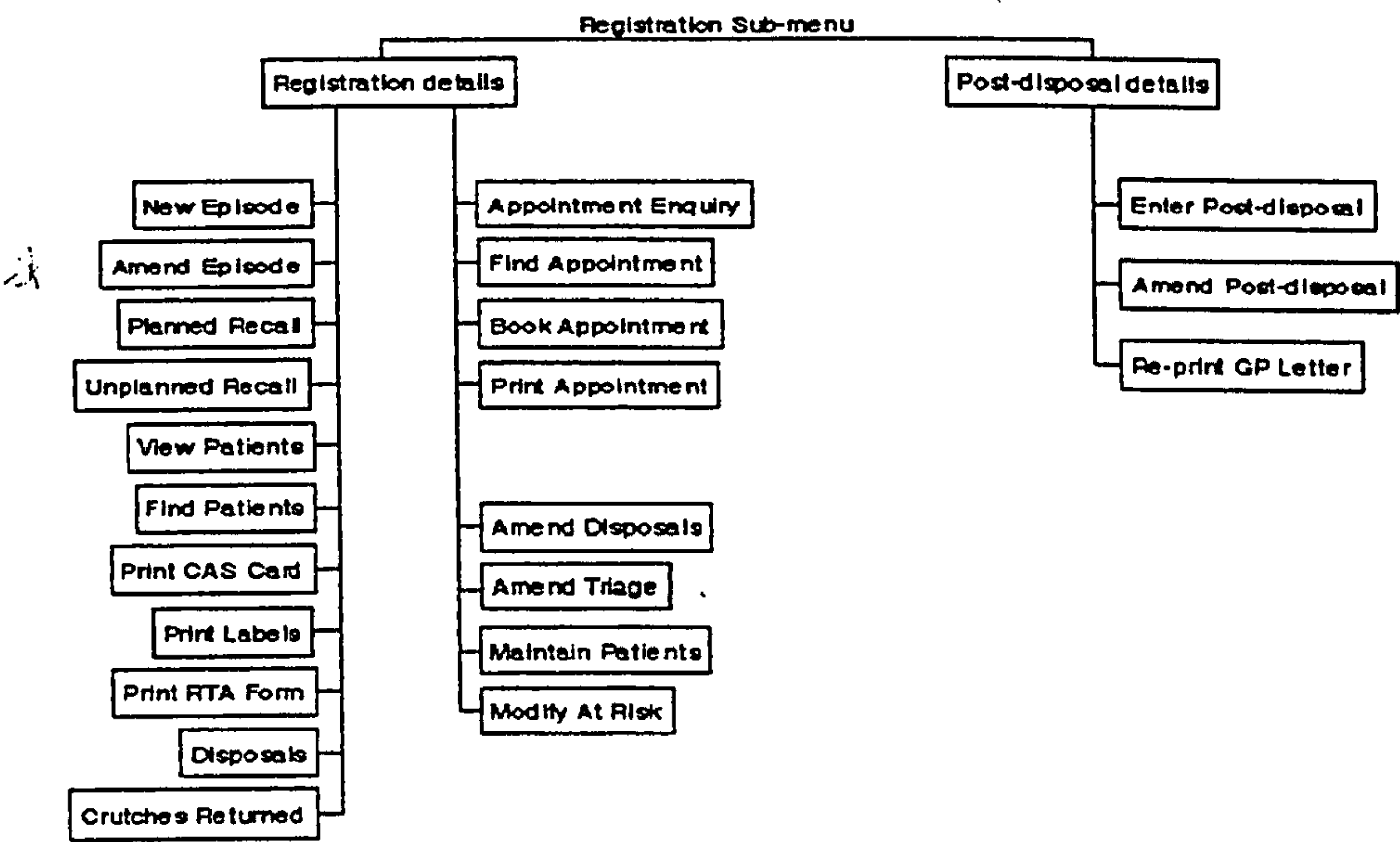
Supervisor

Super User

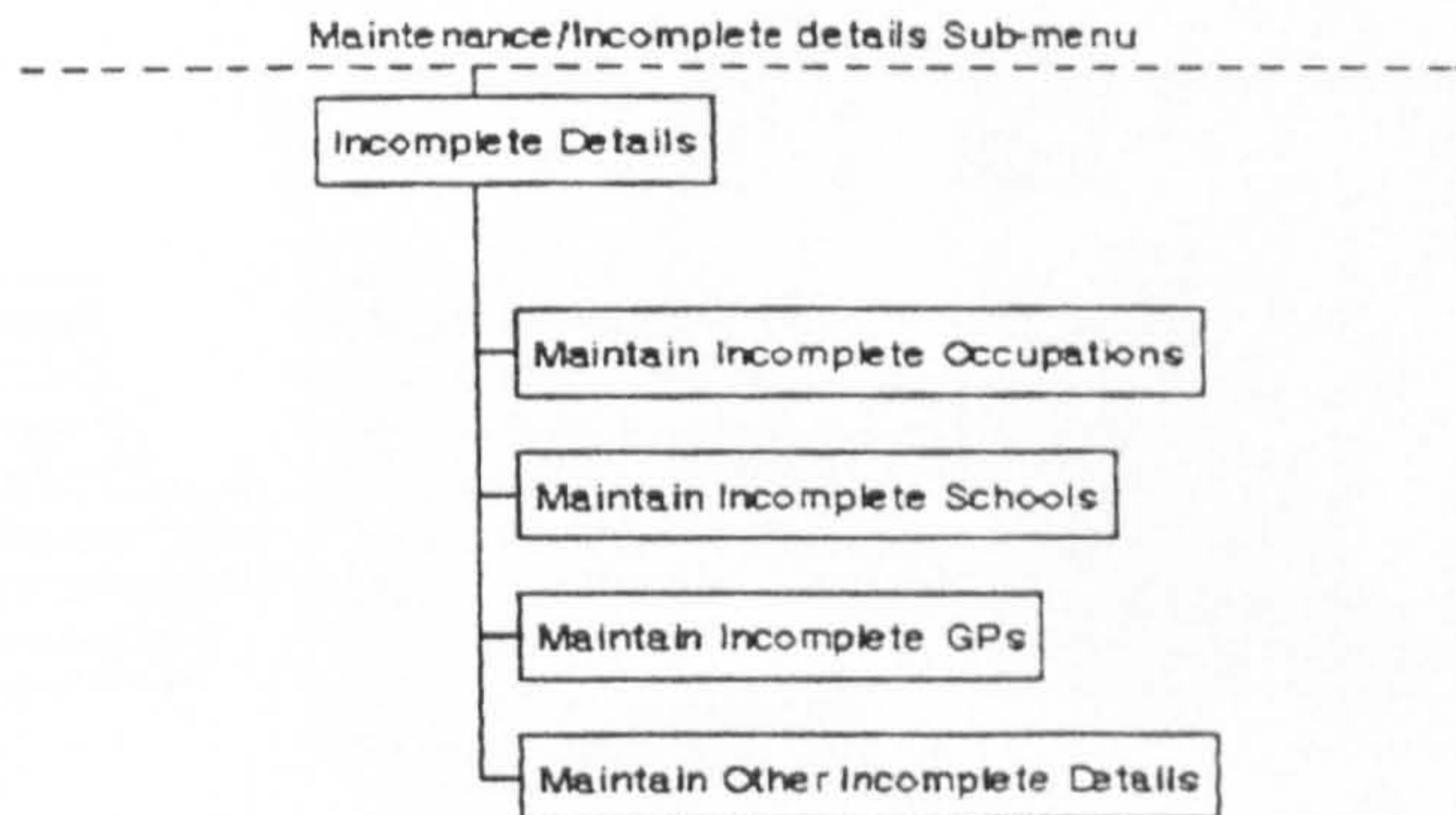
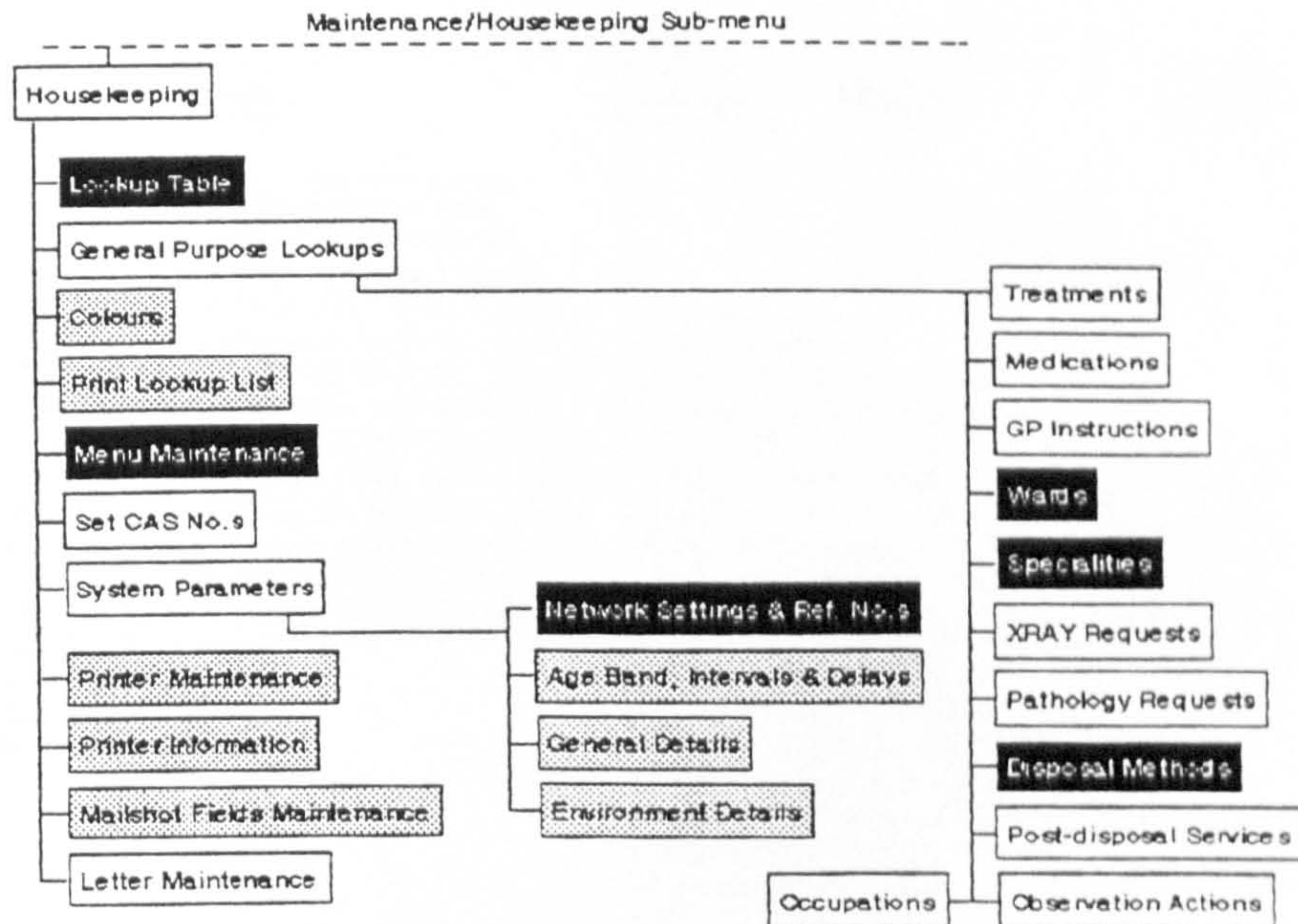
Options shown unshaded are available to Standard and Manager users, options shown shaded are available to Supervisors and those shown in inverse are only available to Superusers in the standard setup of the A & E system.



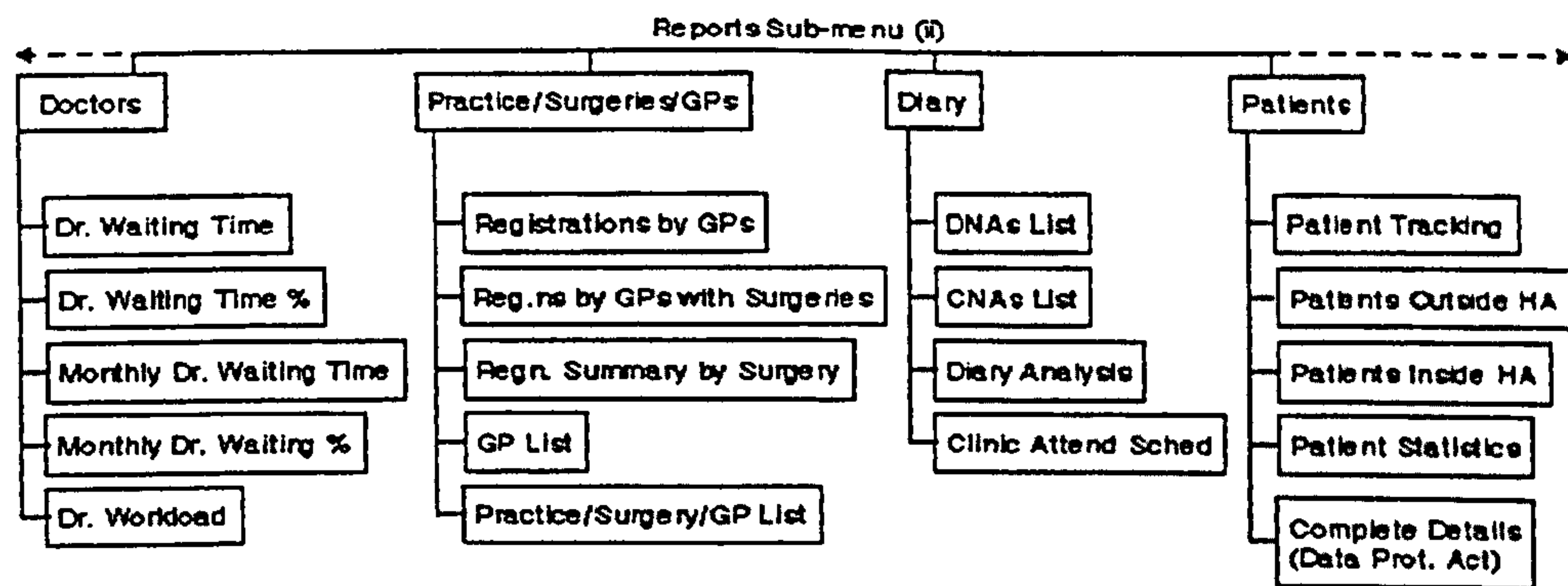
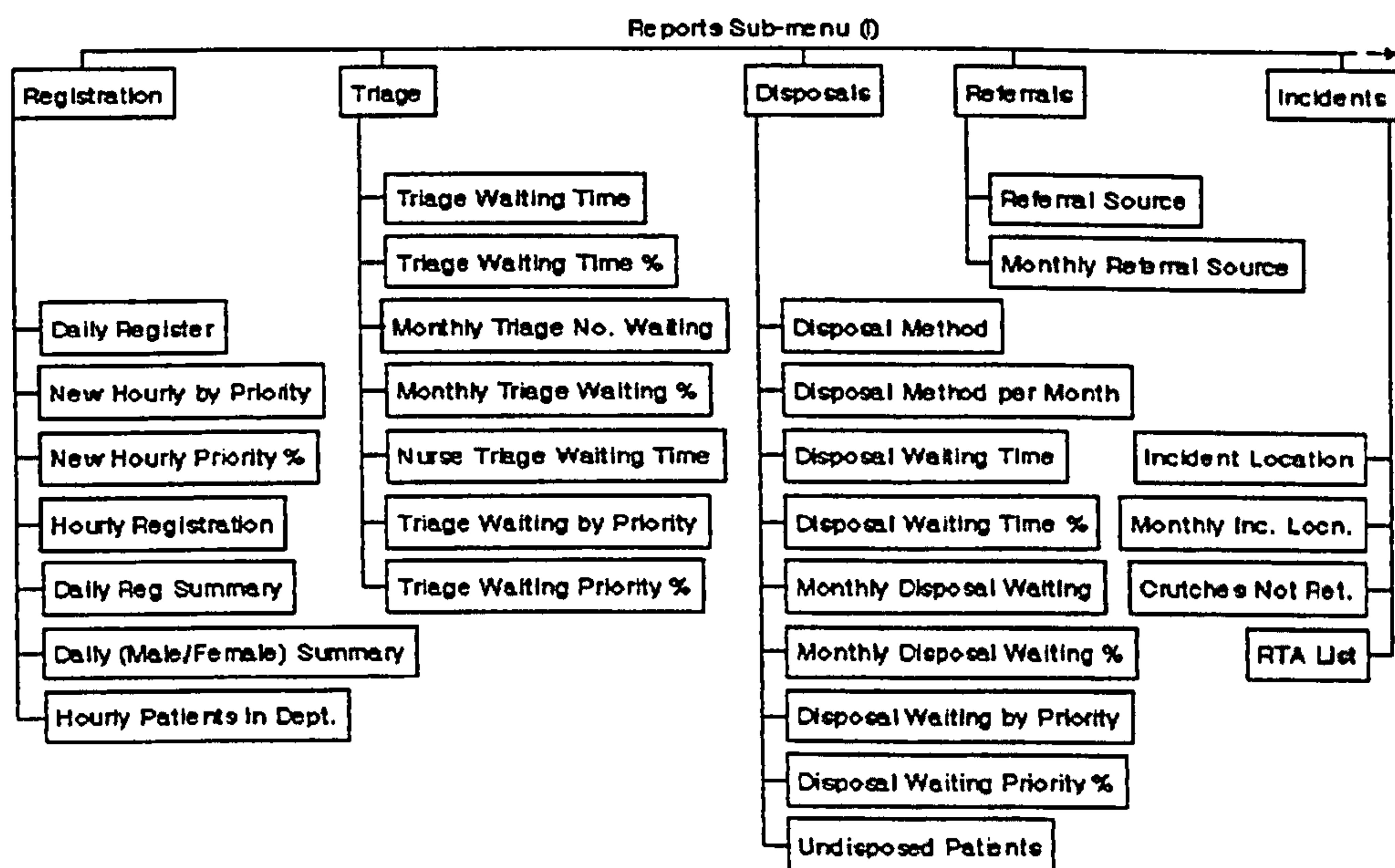




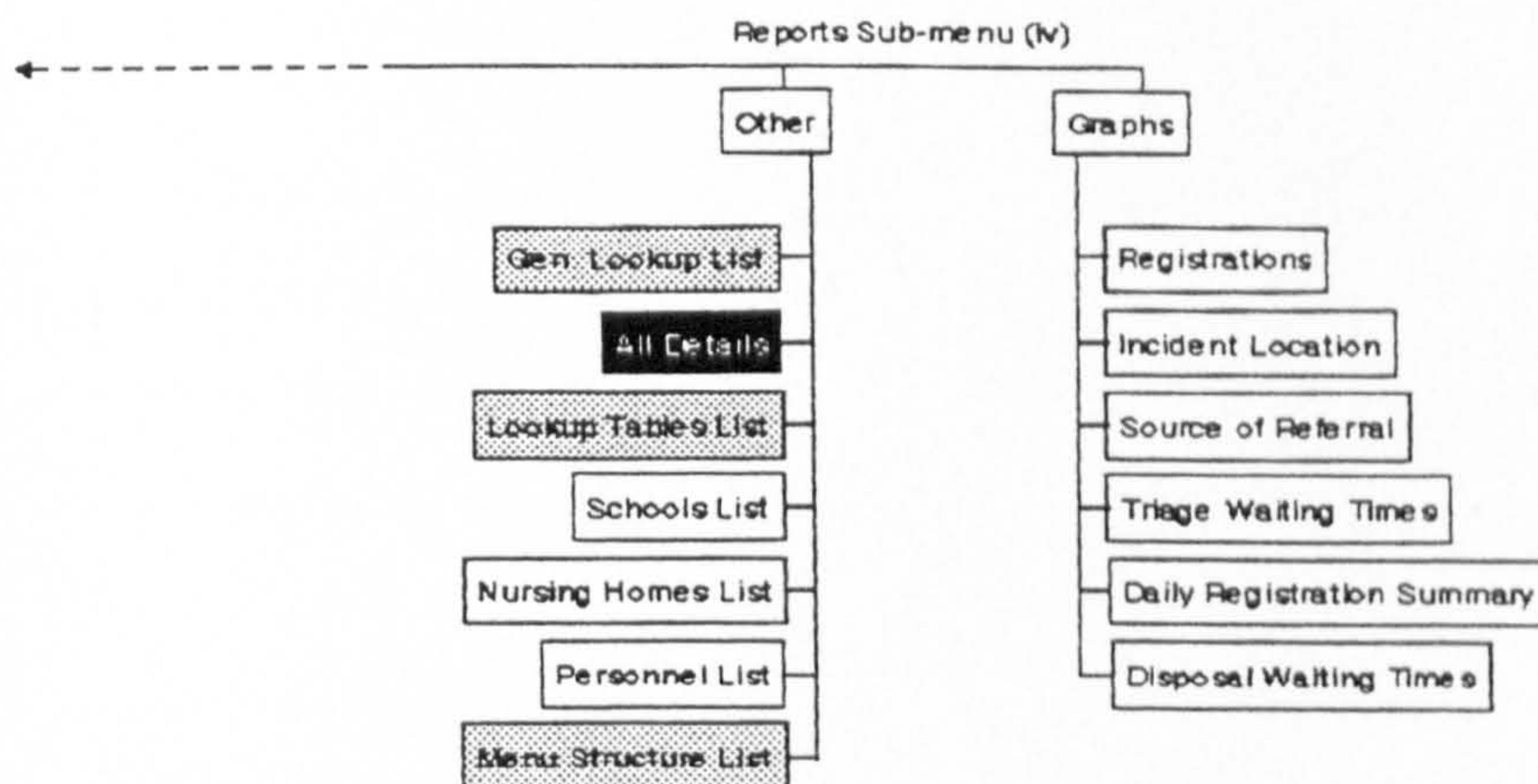
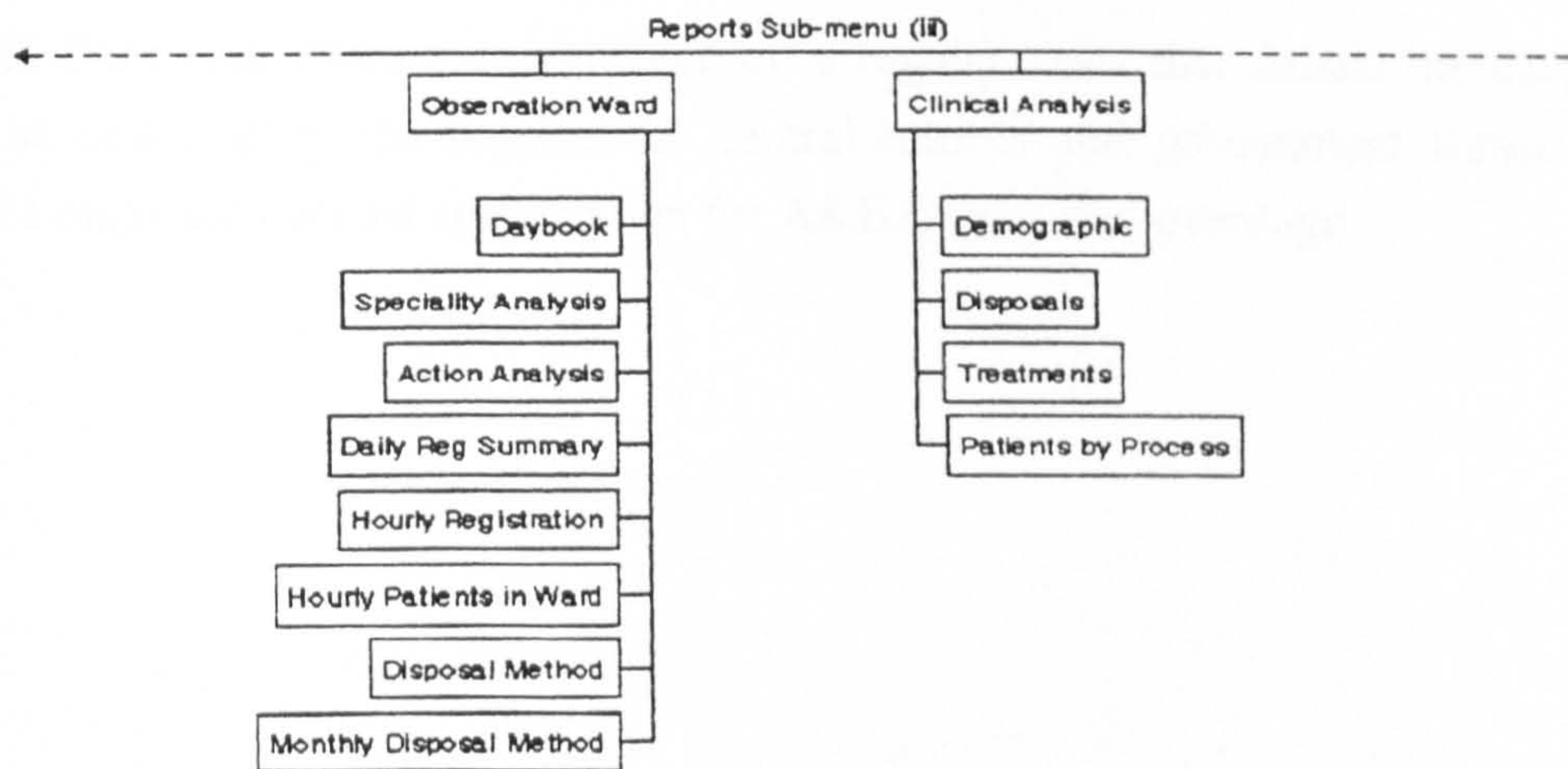
## Appendix A: Menuflow Diagrams







## Appendix A: Menuflow Diagrams





# Appendix 4: NHS Minimum Data Set Specification for A&E Departments

The NHS Executive issues a data manual on a regular basis that details the data items that must be collected by the hospital for central returns and government statistics. An example of a minimum data set specification for A&E is provided overpage.

**A&E Departments with computerised systems  
(DSCN 19/92)**

Data Item	Field	
	Size	Type
<b>Contract Details</b>		
Contract Identifier [provider code, purchaser code, serial number]	16	A/N
<b>Patient Details</b>		
NHS Number <i>(not mandatory at present)</i>	17	A/N
Patient Name	35	A/N
Patient's Usual Address	105	A/N
Postcode of Usual Address	7	A/N
Health Authority Code (of residence)	3	A/N
Sex	1	
Marital Status	1	
Birth Date	8	
Code of GP (Registered)	8	A/N
<b>Attendance Details</b>		
Code of GP Practice	6	A/N
Local Patient Identifier	10	A/N
A&E Attendance Category	1	
Arrival Date	6	
Source of Referral	1	A/N
A&E: Arrival Mode	1	
Arrival Time	4	
A&E: Patient Group	2	A/N

**Key:**

- + Item derived from appropriate source items in provider mds
- A/N field is alpha/numeric; all other fields are numeric
- x to be collected by the provider, but not required to be submitted in the contract minimum data set
- # at least one of these items must be provided



**A&E Departments with computerised systems  
(DSCN 19/92)**

Data Item	Field	
	Size	Type
A&E: Incident Location Type	2	A/N
A&E: Initial Assessment Time	4	
A&E: Time Seen for Treatment	4	
A&E: Staff Member Code	3	A/N
<i>Investigation Code</i>		
- First	6	A/N
- Second	6	A/N
<i>Diagnostic Code</i>		
- First	6	A/N
- Second	6	A/N
<i>Treatment Code</i>		
- First	6	A/N
- Second	6	A/N
A&E: Attendance Conclusion Time	4	
A&E: Departure Time	4	
A&E: Attendance Disposal	2	

**Key:**

- + item derived from appropriate source items in the provider mds
- A/N field is alpha/numeric; all other fields are numeric
- x to be collected by the provider, but not required to be submitted in the contract minimum data set
- # at least one of these items must be provided

## **Appendix 5: Draft Requirements Specification for the Existing A&E Healthcare Information System**

This appendix provides an original draft requirements specification for the existing A&E system. This requirements specification provided background information for the data collection process as described in Chapter 4.



# **AED System**

## **Draft specification**

### **OVERVIEW**

#### **Registration**

- Register patients
- Print labels and CAS card

#### **Triage**

- Select patient and enter details

#### **Disposal**

- Enter disposal details

#### **Post discharge information**

- Enter clinical and admin details

#### **Observation ward (if admitted)**

- Enter observation ward registration and disposal details

#### **Secretary (if admitted)**

- Enter observation ward discharge notes
- Print GP letter

#### **Clinics**

- Make appointments
- Print appointment lists
- Enter DNAs and cancellations
- DNA and cancellation report

#### **Exceptions**

- Add missing patient details
- Check patients with missing details and authorise completion

#### **System management**

- Maintenance of parameters - popups, GPs staff, passwords etc.

#### **Reports**

- Analysis reports and graphs - admin and clinical

## REGISTRATION

This program allows the registration of new patients, recalls, and planned and unplanned re-attendances. The information is split into two parts. Much of the demographic data (eg name and address) is stored on the main patient record and only needs to be entered the first time a patient visits the department. The incident data is specific to the current episode.

The program asks for the patient's name and date of birth and attempts a match from the master patient file. A window of nearest matches is displayed and if the correct patient is found, he or she may be selected. The user can step through and amend any of the master patient details. Alternatively these details may be skipped and control moves to the entry of clinical data.

The patient browse screen can also be used to display an episode history for a patient.

If the visit is a follow up visit, the last episode can be selected and the current clinical details will default to the last visit.

There is a patient find facility and four registration options. Appointments can also be maintained from this screen:

**Patient find:** To answer telephone enquiries, receptionists need to find the last visit of a patient so that they can give a status report. eg Left department or gone to theater.

**New episode:** The patient may or may not exist on file. If the patient exists, demographic details may be amended. If not they are added. A new episode is created.

**Amend episode:** Find a patient, and select an existing episode from a browse screen. Both the patient and episode details can be amended. The rules for amendment are as follows:

1. All information may be amended up until the disposal details have been entered.
2. After disposal, episode details may only be amended by a higher level operator.

Also note that there is a separate program to amend patient details, which does not access episode information.

**Planned recall:** Displays a browse of patients with appointments for that day and allows a few episode specific details to be entered. Most episode details come from the original episode.

**Unplanned recall:** Patient selected from patient file and episode (usually latest) selected for that patient. A short screen of altered episode information is entered.

**Book appointment:** A patient and episode is found and an AED or AED opthalmic clinic appointment is booked.

**Move or cancel appointment:** An appointment is found and either moved or cancelled.



**Print more labels:** This option allows additional labels to be printed for any patient.

**Return crutches:** This option displays a list of patients with crutches and allows the operator to flag their return.

### **Unknown patients**

In some cases, such as when a patient is brought in unconscious, even basic demographic patient details are unknown. In this case, the system will generate an unknown patient number in place of the name. If the name becomes known at a later date, an option is provided to substitute it. A separate file is maintained to link unknown patient references with names so that any reports printed before the name is known can still identify the patient.

### **Demography**

1. Patient internal reference                      nu 4
2. Surname    ?                      an 20
3. First names    an 20
4. Date of birth    nu 4
5. Date of birth estimated flag                      an 1

List possible matches showing all patients with surname from that point alphabetically. Optionally allow a search on DOB and on surname at birth. Display the number of episodes if the patient is on file.

- 6 Title    an 1
- 7 Surname at birth: default to surname                      an 20
- 8 Sex:                      an 1 M/F/I Male/female/indeterminate
- 9 Civil State:                      an 1 Married/Single/Widowed/Divorced/Separated
- 10 Address perm:                      an 105
- 11 Postcode: 7 -> health authority (& overseas)
- 12 Prev address                      an 30 first 30 characters of the last address
- 13 Prev postcode                      an 7 previous post code
- 14 Health authority:                      CA 3 (not entered)
- 15 Address temp:                      an 105
- 16 Postcode:                      an 7 - temp postcode
- 17 Tel home:                      AN 15
- 18 GP Code:                      fm\_2 on GPs nu 4
- 19 Religion:                      an 1 parameter table  
(RC\CofE\Methodist\Baptist\Atheist\Agnostic\Jehovas Witness\Jewish\Muslim\Christian"
- 20 Occupation:                      AN 20
- 21 Employer:                      AN 40
- 22 Tel work:                      AN 15
- 23 School:                      nu 2 -> lookup/fm\_2
- 24 Next of kin relationship                      an 1 popup
- 25 Name:                      an 20 default to surname
- 26 Telephone day                      an 15
- 27 Telephone night                      an 15
- 28 NOK Address:                      an 105 default to "as above"
- 29 At risk code                      an 1 parameter popup

- \* 30. KPAS no                      nu 7 nb always entered and displayed with 8th character which is modula 11 checksum
- \* 31. NHS No                      an 10
- \* 32. Social class                an 1
- \* 33. Ethnic group               an 1
- \* 34. Death status               an 1 default to 1 (alive)
- \* 35. Date of death               da 4
- 36. Date first entered           da 4
- 37. Entered by                   nu 2 who initially entered patient details

display no of attendances in last 2 years

Items marked \* are not used by AED.

### **Incident details**

- 38. incident number              nu 4 - computer generated
- 39. cas number                   nu 2 - patient no for that day
- 40. Mode of arrival:              an 1 popup  
walking\public transport\private transport\ambulance\police\taxi\other
- 41. Incident location:            an 1 popup  
home 10\work40\education est 40\ public place 60\other 91
- 42. Additional location text      AN 20
- 43. Source of referral:           an 1 popup  
GP booked\GP not booked\self\local authority  
\emergency services\work\police\healthcare provider\other hospital\other
- 44. Who with                      an 1 popup
- 45. Date of incident               da 4
- 46. Time of incident              nu 2 save as minutes since midnight
- 47. Time since incident          an 5 (eg 5m or 7d ie mins and days)
- 48. Group                          an 1 popup  
rta\assault\self harm\sports injury\firework\other\brought in dead\other
- 49. Arrival time                   nu 2 default now
- 50. Arrival date                   da 4 default now
- 51. Entered by                   nu 2 who entered incident
- 52. Type                           ca 1 new/planned follow up/unplanned follow up patient initiated/unplanned follow up hospital initiated.
- 53. Status flag                   ca 1 (see below)
- 54. Authorised by                nu 2 (if incomplete data completion needs to be authorised)

### **RTA**

The following details are only asked if the patient GROUP is specified as RTA. They enable the automatic production of an RTA form.

RTA number computer generated  
 Examined by medical practitioner: y/n  
 type popup - Driver/passenger/pedestrian  
 vehicle popup - Bus/taxi/private vehicle/cycle  
 driver name an 30 name of driver or name of bus company  
 driver address an 105 address of driver  
 vehicles no of vehicles involved in RTA



**Status flag**

The episode status field is set as follows:

- 0 The patient has been registered but not yet triaged
- 1 The patient has been triaged (skipped for planned recalls)
- 2 The disposal details have been entered
- 3 The post disposal details have been entered
- 4 The record is complete
- 5 The record has been authorised as complete

**Planned recalls**

A planned recall is when a patient is given an appointment to return to casualty at the time of the original episode. Patients are given planned appointments for the following reasons:

- AED clinic: Also known as the redressing clinic.
- Ophthalmic clinic:
- XRAY mane: This is when an XRAY is required during the night, but it is more convenient to do it in the morning.

Registrations of planned recalls will use a shortened registration screen. Much of the information will be the same as the previous episode.

All planned appointments will be available on the diary, so the receptionist will be able to select the patient from a browse. This browse and the shortened registration screen should be available as overlays (ie called from) from the main registration screen. The following fields need to be displayed on the browse screen:

Surname, firstname, date of first attendance, cas card no of original incident, cas card found marker, clinic, appointment time, status (ie tick if they have registered for the appointment - you could use colour for this as well). The browse should be in surname order by day. It should also be possible to find any appointment for a requested surname + short firstname.

All details will default to the episode at which the appointment was made except the following:

- Mode of arrival
- Who with
- Date of registration
- Time of registration
- Problem will be set to the name of the clinic (eg AED clinic)

The incident type will be set to Planned recall

Print CAS Card and labels options as per main registration. Note that more details can be printed on the CAS card for recalls.

### **Unplanned recalls**

An unplanned recall happens when the patient returns with a follow up of a previous incident. This can be because the hospital notices a problem (eg when an XRAY is checked) and asks the patient to come back (AED initiated), or because the patient thinks that the original problem has not been fixed and turns up unannounced (patient initiated).

In both cases, the relevant incident will be selected using a browse on patient name followed by incidents for that patient.

The following new registration details will be required:

Mode of arrival

Who with

Problem - default to original problem but allow it to be overwritten

Source of referral

Date of registration

Time of registration

The incident type will be set to Unplanned recall patient initiated or Unplanned recall AED initiated, according to the source of referral.

Print CAS Card and labels options as per main registration. Note that more details can be printed on the CAS card for recalls.



## TRIAGE

The standby triage screen will display a list of registered patients waiting for triage. The time elapsed will be displayed next to the patient. The records will be displayed in one colour if time elapsed is less than time1 (parameter), another colour if greater than time1 and less than time2 and a third colour if greater than time2. This screen will update automatically every x (user definable parameter) seconds.

The details displayed on the browse will be patient's names, problem, recall flag and registration time.

A patient can be selected for triage and the following details entered:

Triage time:	nu 2 default now
Priority:	an 1 1-5 (1 immediate, 2 urgent, 3 routine, 4 not applicable, 5 DNW)
Area:	an 1 resus/major/minor/DNW (auto DNW if priority is DNW)
Triage nurse:	nu 2

The following patients do not go through the triage process:

- 1 Unplanned AED initiated patients are automatically assigned priority 1, area unknown. The triage screen is not used.
- 2 Planned recalls (ie patients who have been booked on appointments), do not pass through triage at all.

### DNWs (did not wait)

If a patient called by the triage nurse does not answer they will be entered as a DNW area and priority. DNW records must remain on the triage screen until they are disposed of. The triage time should be fixed at the first time the patient is called.

If a DNW returns, the area and priority can be entered as usual. If the DNW does not return, they will be disposed of as left department. In this case, the priority and area remain as DNW.

At disposal, DNW patients can be entered as DNW - before triage or DNW after triage. Both types of DNW patients are listed in a separate column on the doctor's waiting time and time before disposal reports.

## DISPOSAL

The disposal screen will allow the user to enter the name of the outgoing patient or select from a list of registered patients still in the department. Once the patient has been selected, the following details may be entered.

Disposal time:        nu 2   default now (if by ambulance, time is when it arrives)  
Method:               an 1   parameter popup  
immediate theatre/admitted hosp/admitted obs/admitted faz/admitted alder hay/discharge to  
GP/discharge/A&E clinic/# clinic/ent clinic/mfu clinic/oph clinic/did/referred  
paramedic/left department/own discharge/triage discharge/XRAY mane  
Transport method    an 1   parameter popup  
Disposer             nu 2   person who authorised disposal  
Operator             nu 2   person who keyed in disposal details

if disposal = admit  
ward                  an 2   (reference file)  
consultant        nu 2   (reference file)  
specialty            an 1   (lookup 40 items)

If the patient is disposed of to an AED clinic (ie opthalmic or redressing), the system allows appointments to be made through the clinic diary program. This is a visual diary and calender program which allows appointments to be made, moved and cancelled by moving a cursor to a time slot.

XRAY Mane patients are automatically given appointments for the following day. If the disposal time is after midnight and before 09:00hrs the appointment will be made on the current day.

The same diary routines are used to register appointment changes and cancellations made by phone.



## **THE DIARY SYSTEM**

The dairy system maintains appointment details for the AED attached clinics and XRAY mane patients. This part of the system allows appointments to be made, moved and cancelled. It also produces statistics on numbers of patients seen and DNAs.

### **Description of the clinics**

XRAY Mane: All appointments are at 9am. There is no limit to the number of appointments per day.

AED Clinic: Appointment booking availability is as follows:

8 - 10	10 patients
10 - 12	10 patients
12 - 2	5 patients
2 - 5	5 patients
5 - 7	5 patients

Ophthalmic clinic: All appointments at 9:30 - unlimited number

The system will allow changes to the booking availability schedule on a daily basis. Thus, on a public holiday, for example, the number of slots on morning sessions could be reduced to 5.

### **General facilities**

All appointment booking routines are available from a main menu option aswell as from the registration and disposal screens.

The user can move between days by entering a date, paging backwards and forwards one day at a time or by selecting a date from a calender.

There is a find first appointment option which locates the first free appointments slot from today.

There is a find next free appointment option which locates the next appointment slot after the date and time slot currently being pointed at.

There is a global view option which shows slot utilisation graphically. This allows the user to look at an entire week on one screen and find empty slots visually.

There is an appointment browse option which lists all patients with appointments for a specified day in name order across clinics. The fields listed are the same as those in the planned recall patient selection screen used in registration.

### **Options**

**Make new appointments:** After disposal, the current patient can be given an appointment by moving the cursor to an empty slot and accepting the appointment. From the registration screen, the patient is found in the usual way before the appointment is allocated. Note that all appointments have to be linked to episodes so that the correct CAS cards can be found.

**Move appointments:** This allows an appointment to be picked up and moved to a different date and time.

**Cancel appointments:** This allows an appointment to be found and cancelled.

**Find CAS card:** The CAS card relating to the original episode has to be located and put into the CAS card tray for the appropriate clinic. This option allows the user to browse through patients booked into clinics for a specified day and mark those for whom CAS cards have been found.

**Reports:** The system can produce a clinic attendance schedule, an attendance analysis and a DNA listing and analysis.



**POST DISCHARGE INFORMATION**

This information can be entered at any time after the patient has left the department. The details come from the hand written entries on the casualty card (incident file).

***Complaint, diagnosis and treatment***

Diagnosis	40 bytes transaction file - can be lots per patient
Treatment	10 * 5 bytes reference to lookup file
Treatment flag	10 * 1 byte - Prescribed or Given flag
Crutches return date:	da 4 blank if not issued

***Specialty doctors***

There may be one, two or no specialty doctors for each patient.

Specialty 1	nu 2	specialty reference
Time specialty 1 requested	nu 2	
Time seen by specialty 1	nu 2	
Specialty 2	nu 2	specialty reference
Time specialty 2 requested	nu 2	
Time seen by specialty 2	nu 2	
Consultant	nu 2	duty AED cons unless GP booked (source of ref)
GP instructions	5 * 5 bytes reference lookup	
GP letter	an 1	yes if GP letter to be sent
XRAY agreed	an 1	y or n
Incidental findings		another diagnosis screen

***Personnel and times***

Operator	nu 2	person who keyed in post disposal information
Nurse	nu 2	(entered)
Nurse Observation time	nu 2	
AED Doctor 1 ref	nu 2	not if GP booked
Time seen by AED doctor 1	nu 2	
AED Doctor 2 ref	nu 2	
Time seen by AED doctor 2	nu 2	
Time fit for disposal	nu 2	

***Investigations (transaction file)***

Type	an 1	XRAY/Path/ECG
Desc code	an 2	Code for test or XRAY (N/A ecg) lookup file-ECG returns ECG
Time Sent	nu 2	Default to previous tran if there is one
Time Returned	nu 2	Default to previous tran if there is one
Interpretation	an 1	(normal\abnormal\incidental finding)
Measurement	nu 2	quantity width 3 - path only, display units from lookup file

The Part to XRAY and Pathology test descriptions are stored on a lookup file. In the case of path tests, the units in which the results will be delivered will be stored at the end of the description with a suitable delimiter. This should be transparent to the user (ie a field should be requested on the maintenance screen. It could be a seperate field on the file if this is easier as there are not many records in the lookup tables.

***Amending post discharge information***

Post discharge information may be added and amended up to 7 days (parameter) after the discharge date. After this details may only be amended by a more senior member of staff.



**OBSERVATION WARD**

The observation ward module consists of four components:

- Registration and admission
- Status
- Disposal
- Post-disposal details

**Admission**

Patients may be admitted onto the observation ward from a number of sources. The majority are admitted from AED. If an episode is selected, default to the consultant and specialty entered in disposal details.

The following details will be entered for each admission:

- Patient name - same search as AED registration. Add patient if not already on file.
- Allow the user to select an existing episode if the latest incident was disposed of to the observation ward.
- Unit no - this is like the KPAS no on demographic data (NNNNNNNA ? check)
- Date of admission
- Time of admission
- Source - popup list, default to AED
- Reason - popup list
- Injury (40 char free text, used in the episode browse)
- Consultant - default to value on AED disposal screen if AED episode
- Specialty - default to value on AED disposal screen if AED episode
- Bed no - 1 - 16 (make maximum a parameter/allow temporary beds)

Each admission will have an admission number which will increment automatically starting at X.

Note that an inpatient episode on the observation ward creates a new episode which will appear on the incident/episode browse screen. The department will be OBS.

**Status**

This is a browse which shows the current status of the ward at any time. It lists the beds, the name of their occupant (or vacant), the date and time of admission, the specialty and the patients' status. The screen looks as follows:

Bed	Date	Time	Patient name	Specialty	Patients Status		
					Doctor	Tests	Other
1							
2							
3							
...							

From this screen, the user should be able to amend the diagnosis and status and also move the patient to another bed.

The patients' status is divided into three categories: doctor, tests and other. Against each patient a colour coded block will be used to specify whether the status for that category is nothing requested (say black), waiting for action (say red) and service requested and supplied (say green).

A bed can be selected with the bouncebar and the following details are entered to update the patient's status:

Category:	Popup - "Doctor\Tests\Other"
Action:	Browse - different lists for each category
Destination:	Only entered if action is awaiting transfer or awaiting inpatient bed. These actions are options on the "Other" action lists. There is one list of options for transfers and another for awaiting bed
Date requested:	default now
Time requested -	default now
Date delivered -	default blank - + and - keys
Time delivered -	default blank

Note that more than one action may be selected for each category so a browse/post screen would be appropriate here. The actions are currently specified as full descriptions but a short (say 5 char) description will be defined for display on this screen.

**Doctor's rounds mode:** When a specialty doctor comes to make a ward round, it is necessary to see all patients waiting to see that doctor. To achieve this, allow a toggle on the status screen which replaces the doctor/tests/other options with Dr1, Dr2 and Dr3. Under these headings display the short code of the specialty of up to three doctors being waited for. NB the specialty list is contained in the action code in this program.

On this screen, the injury will be displayed in place of the date, time and specialty.

**Temporary beds:** Allow them to set up temporary beds. These can be used when a patient has been discharged but is waiting for transport. They can also be used to swap patients between beds (ie put A into temp bed, B into bed A and then A from temp bed into B). Temporary beds could be a different colour.

**Nurse to speak to relatives:** Give an option to mark a patient with an asterisk (\*), signifying that if relatives call, the nurse is to speak to them. This asterisk should be displayed on the status screen.



**Disposal**

The disposal screen will allow the disposal of any patient in the observation ward. The disposal details are:

Date of disposal

Time of disposal

Nurse

Discharge type - like AED disposal but no observation ward

Time ambulance booked (blank if none ordered) - default to action time for ambulances

Return trip ambulance booked - Yes or No

Services - list of six services (variable) use tick boxes to select one or more.

Case note - set to Full or Temp

**Observation ward post-disposal**

The observation ward post-disposal screens are similar to the AED post disposal screens. Note that when a patient's post disposal details are entered for the first time, the diagnosis, treatment and investigation details should be copied from the AED episode if there is one. Do not allow obs ward post-disposal details to be entered if the patient came from AED and the AED post disposal details have not been entered yet.

Only patients admitted with AED as the specialty will have post-disposal details entered

**Screen 1**

Treatments as AED

Date crutches due back as AED

Time fit for disposal as AED

**Screen 2**

GP instructions as AED

GP letter the reference of the letter required (selected from browse)

Additional letter text y/n

Ward round Dr 1 and time as AED Dr 1

Ward round Dr 2 and time as AED Dr 2

**Screen 3**

Diagnosis screen as AED.

**Screen 4**

Investigations as AED

XRAY agreed as AED

Incidental findings as AED

### ***Amend options***

Options are required to amend all observation ward details including registration, disposal, post disposal and action requests.

### ***GP LETTERS***

GP letters are stored in a number of letter templates with the following mailmerge fields:

#### **Demographic**

Patient name: title + first name + surname

Patient address

Unit no

GP Name: "Dr" + GP name with initials moved from the end to the beginning

GP address: mailing address according to mailflag

#### **Episode**

Episode number (cas no for AED patients)

Registration date

Disposal date

Disposal method

Consultant

Treatments: "The following treatments were given:" followed by treatments separated by semi-colons

Diagnoses: all diagnoses concatenated and separated with semi-colons

GP instructions: "The followup required is as follows:" GP instructions separated by semi-colons

Investigations: "The following investigations were undertaken" followed by a table with investigations and results.

Services arranged: observation ward only: The following services have been arranged: services separated by semi-colons.

Additional text: observation ward only

The texts (eg The following investigations were undertaken) should be parameters.

### ***Mandatory fields***

All of the above fields, except for Unit number are mandatory fields, and must be entered before a GP letter can be printed (services and additional text only mandatory when printing observation ward letters).

This means that treatments, GP instructions and investigations for example must be entered as none and not simply left blank. Also, it is not possible to print a letter for a patient with an unknown GP.

If an attempt is made to print a GP letter for a patient with incomplete data, the error message should list all mandatory fields with those missing flagged in some way (colour?).

### ***Number of copies***

Whenever a GP letter is printed, the program must ask for the number of copies required.



***Number of times printed***

The system should maintain a field which registers the number of times a GP letter is printed for an episode. Note that this is the number of times the letter is printed irrespective of the number of copies. This field is used to show that the letter has already been printed one or more times.

***Printing GP letter after AED post disposal details***

If the GP letter flag is set to Y, the operator should be given the option to print a GP letter each time post disposal details are either entered or amended.

***Ad-hoc printing of AED GP letter***

This program should allow a patient episode to be selected in the usual manner and a GP letter to be printed irrespective of the status of the GP letter flag.

***Printing GP letter after observation ward post disposal details***

This operator should be given the option of printing the GP letter specified. Note that although the print option will be given, the letter will not print if additional letter text has been specified, but not entered.

***Ad-hoc printing of GP letter after observation ward post disposal details***

This program will allow the user to select a patient observation ward episode in the usual way. If additional text is required the operator should be able to add or amend the additional text field at this point. The operator should also be able to change the setting of the additional text flag at this point, as it may have been entered incorrectly or the consultant may have changed their mind about the extra text. The secretary should also be able to switch to a different standard letter.

This program needs an additional browse screen to show observation ward patients with post-disposal details entered and GP letters outstanding (ie where the number of times printed is zero). Letters which cannot be printed because additional text has been requested but not entered should be highlighted with an asterisk. Note that as non AED patients do not have post-disposal details, they will not appear on this list.

**GPs**

A practice is a business run by one or more GPs. A practice will usually have a surgery at the same address and will often run one or more satellite surgeries. A GP may work at one or more surgeries and occasionally belongs to more than one practice.

GP data is stored in four files:

**GP file:** The GP file contains the static information about a GP. Note that the GP code lives with a GP for the duration of his/her career, irrespective of changes of practice and surgery.

Cref            nu 2 system c internal ref  
Code            AN 8  
Name            AN 30 surname followed by initials

**Practice file:** This file contains the details of the practices the GP's belong to. Every GP must belong to a practice.

Cref            nu 2 system C internal ref  
Practice Code    an 6  
Name            an 25  
Address          an 105  
Fundholder code   an 5 blank if not a fundholder, U if unknown  
Senior partner ref   nu 2 system C internal ref  
Date formed       da 4  
Date closed       da 4  
Date fundhldr start   da 4  
Date fundhldr stop   da 4  
Wave            nu 1 for fundholders (1 - 9)  
FHSA code        an 3 family health services association ref  
PPA number       nu 2 prescription pricing  
Internal mail     an 1 is the GP on the internal mail service  
Status           an 1 1 - live, 2 - dissolved

**Surgery file:** This is the surgery address that the patient visits.

Surgery ref       nu 2 Internal reference  
Address           an 105 This is the surgery address  
Postcode          an 7  
Practice           nu 2 Internal reference



**GP/surgery/practice link file:** This file ties GPs, surgeries and practices together. A practice may have more than one surgery and will almost certainly have more than one GP. A GP will be assumed to work at all surgeries belonging to his practice and may work at more than one practice. If a GP leaves one practice and joins another, both sets of records will be in place.

Surgery ref	nu	2	Internal reference
Practice ref	nu	2	Internal reference
GP ref	nu	2	Internal reference
Mailflag	an	1	S - mail to surgery/P mail to practice
Status	an	1	practicing/left/retired/died/incomplete
Date joined	da	4	date joined
Date left	da	4	date left/retired/died
Practice code	an	6	needed for reporting
GP code	an	8	needed for reporting

### ***Using GP Data***

Initially GP data will be downloaded from KPAS. A single program will be available to maintain GPs, practices and surgeries. It will be possible to list GPs and surgeries belonging to a practice.

Whenever a GP code is used in the system, it is always a composite code made up of the surgery code + the GP code.

When registering patients, if the GP/surgery is not on file, only ask for the GP name and address. The patient is unlikely to know any other details. Set the practice code to a code reserved for Unknown. Incomplete records should be maintained at a later date. An option on the GP maintenance program will list GPs with incomplete data and allow the rest of the GP and surgery information and links to practices to be added where required.

Note that it is possible that AED will not keep the GP file up to date at this point. In this case, you could end up with hundreds or even thousands of surgeries attached to the Unknown practice. When other departments come on line, the GP data will be crucial and will always be maintained.

**LOOKUP FILES****Personnel file**

This file is used both for users of the system (who need passwords) and other medical staff who are needed by the system (eg specialty doctors).

Cref	nu	4	System c internal reference
Type	an	1	Parameter popup - nurse/staff nurse/doctor/consultant etc
Local Code	an	4	Local hospital code
GMC code	an	8	General Medical Council code (only for some types)
Name	an	30	
Inits	an	6	Initials
Firstname	an	20	
Title	an	1	Mr/Dr/Mrs/Ms/Miss/Prof
Password	an	8	If password is left blank, this is not a user.
Address	an	105	
Phone	an	15	
Specialty	nu	2	Consultants only - lookup on the specialty file. 6 specialties per consultant
Joining date	da	4	
Leaving date	da	4	NB date must be between these dates for member of staff to be valid.

**School file**

Internal code	nu	4
Code	nu	6
Name	an	30
Address	an	105
Postcode	an	7
Telephone	an	15
Contact	an	30

**General purpose lookup file**

This single file is used to store the following lookup tables:

Treatments  
Medication  
GP instructions  
Wards  
Specialties  
XRAY request  
Pathology request.

Internal code	nu	4
Access code	an	5
Table	an	1 denotes which table is being looked up
Description	an	60

Note that the pathology code should use a delimiter in the description to specify the units.  
eg xxxdescxxx/gms.



## GENERAL PROGRAMS/FACILITIES

**Patient maintenance program:** This program allows maintenance of the master patient file. Episode data may not be maintained from here. The program has the same patient search facilities as registration.

**Adding missing data:** Patients and incidents will not be flagged as complete until all mandatory data has been entered. Missing data can be added later by a senior member of staff using this program. The program will include a browse of incomplete records. The program allows the operator to approve the completion of records where data is still missing.

The following fields are mandatory:

**Patient:** Surname, first names, date of birth, permanent address, GP ref, next of kin relationship, name and phone numbers.

**Incident:**

**Triage:** All details unless the episode is a planned recall.

**Disposal:** All fields

**Post discharge:** TBA

The program will use a browse screen to display records with missing data. The type of data missing and the operator who originally entered the details will be indicated.

**Standard letter maintenance:** This program allows a file of standard letters to be built. These letters can include various fields from the system such as patient name and address, GP details, diagnoses and treatments. These letters are normally used to inform schools and GPs about attendance at AED.

**Period end:** This program, which much be run monthly, deletes information held for a finite period. For example appointment records over three months old are physically deleted from the system.

The period end program will also archive and clear down the audit files.

**Parameter file maintenance:** This program is a system maintenance option which allows all parameters such as next internal reference counters, next RTA number, system colours, and popup option lists to be maintained. This program may only be used by the senior supervisor, with approval from System C (ie additional password).

**Operator maintenance:** This program, only available to the system supervisor, allows the set up of new users and their access levels. It includes a user profile facility which means that an operator can be given access by profile, rather than having to enter every access to every program for every user.

**Audit trail:** Every addition, amendment or deletion to all files must be written to an audit trail. Save the new record in a memo and key it on file + date + time.

**REPORTS**

- 1. Cas card
- \* 2. RTA form
- \* 3. Labels
- \* 4. Daily register

Prints a daybook with the following: surname, name, time registered, priority, area, disposal time and disposal method.

- 6. GP letters

Prints a letter for a selected range of patients in date and CAS no order. Uses a standard letter format. Letters only printed if the GP letter flag is set to Y.

- \* 8. Daily registration summary

Summarises the total number of patients registering each day, over any range of dates, and gives a breakdown of new and follow up patients, adults and children and planned and unplanned follow ups. This report also prints a percentage of follow ups of all registrations.

- \* 9. Daily registration summary - male/female breakdown

As registration summary but all patient categories broken down into male and female.

- \* 10. Hourly registration report

Summarises the number of registrations in each hour for any range of dates. Registrations are analysed by new and follow up, unplanned and planned follow-ups and adults and children.

- 10.a Hourly registration report - analysed by priority

As hourly registration report but the analysis is by priority code within area.

- \* 11. Hourly analysis of patients in department

As hourly registration report but reports on the number of patients actually present in the department in each hour.

- \* 12. Incident location report

A summary of all registrations for any range of dates analysed by incident location.

- \* 13. Monthly incident location report

Percentage of incidents for each location reported for each month of the given year.

- \* 14. Source of referral report

A summary of registrations for any range of dates analysed by referral source.

- \* 15. Monthly source of referral report

Percentage of referrals for each source for each month of a given year.



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\* **16. Disposal report**

A summary of registrations for any range of dates, analysed by disposal type.

\* **17. Monthly disposal report**

Percentage of referrals for each disposal category for each month of a given year.

\* **18. Registrations by GP**

Summary of registrations for any range of dates analysed by GP. This report includes an analysis of new attendances, planned and unplanned follow ups and inappropriate attendances..

\* **19. Registrations by GP within practice**

As registrations by GP, but groups and sub-totals GPs by practice.

\* **20. GP practice summary report**

As registrations by GP, but prints a single line with the totals for each practice.

\* **21. Waiting time reports**

These three reports print the following waiting time analysis for any range of dates: registration to triage, registration to seen by doctor and registration to disposal. The reports are available graphically as well as numerically. Note that the operator may select the time interval for the analysis (eg 15 minute intervals) and the maximum time to be analysed (eg everything over 6 hours goes into a single interval titled 6:00 +).

The triage time report can be printed by nurse across a range of dates.

\* **22. Waiting time reports (priority analysis)**

The same as waiting time reports but analysed by priority code.

\* **23. Crutches not returned report**

List of patients who have not returned crutches. The list prints the patient's name, address, phone numbers and initial registration date. Note that this report includes observation ward patients.

\* **24. AED report - full listing**

Complete list of all registration, triage, disposal and post-disposal information data entered for any range of dates. This is effectively a computer generated CAS card with all details printed.

**25 GP listing**

A listing of all GPs, either in alphabetical order, surgery order or practice + surgery order.

**26 Personnel listing**

A list of all personnel known to the system.

**26 Schools listing**

A list of all schools

**27 Lookup tables listing**

A list of all lookup table options.

**28 Clinic: attendance schedule**

This is a list of names, problem, original attendance date, original cas no and CAS card found flag for any range of dates and clinics. It is used at the clinic so that the receptionists know who to expect and by the clerks finding the CAS cards for clinics.

**29 Clinic: attendance analysis**

A report showing the number of attendances to each clinic session across any range of dates. Also a report showing the weekly attendance pattern (ie average session attendance for each session on each day of the week) across any range of weeks.

**30 Clinic: DNA report and analysis**

The number of appointments and DNAs for each day for each clinic sub-totalled by week for any range of days and clinics. Optionally list the names, CAS card numbers and telephone numbers of patients not attending.

**31 Observation ward: Day book**

Admission no, Name, Unit no, Time admitted, source, consultant, specialty, disposal time, disposal method, ward and problem for any range of dates.

**32 Observation ward: specialty analysis**

For any range of dates print the number of admissions and average length of stay for each specialty. Include report totals.

**33 Observation ward: action analysis**

For any range of dates, the number of times requested and average wait time for each action, printed and subtotalled by category.

**34 Observation ward: daily registration summary**

Summarises the total number of patients registering each day, over any range of dates, and gives a breakdown of male/female, source: AED/other, Reason: (3 reasons).

**35 Observation ward: hourly registration report**

Summarises the number of registrations in each hour for any range of dates. Uses the same analysis as the daily registration summary.

47

**36 Observation ward: hourly analysis of patients in ward**

As hourly registration report but reports on the number of patients actually present in the ward in each hour.



### 37 Observation ward: disposal report

A summary of registrations for any range of dates, analysed by disposal type.

### 38 Observation ward: monthly disposal report

Percentage of referrals for each disposal category for each month of a given year.

### 39 Data protection act report

Print out ALL of the demographic and episode details for a specified patient.

### 40 Doctor's workload report

For any range of dates, for each AED doctor, print:

- \* The total number of patients seen
- ✓ \* The number of planned recalls where the doctor was the AED doctor on the original incident
- ✓ \* The number of unplanned recalls where the doctor was the AED doctor on the original incident
- ✓ \* The total number of patients investigated (ie where any type of inv is requested)
- ✓ \* The total number of investigations (count all investigations requested by doctor)
- \* The number of patients XRAYed
- ✓ \* Percentage of these patients with normal, abnormal and incidental findings
- ✓ \* The total number of parts XRAYed (can be more than 1 per patient)
  - \* The percentage of normal results recorded
  - \* The number of patients with pathology tests
  - \* The total number of pathology tests (can be more than 1 per patient)
  - \* The percentage of normal results recorded
- \* The number of patients with ECG test requested
- \* ~~The percentage of normal results recorded~~

The Dr has seen a patient if he/she is AED Dr 1 or 2. It is always AED Dr 1 that requests investigations. If there is an AED Dr 2, it is this doctor that is responsible for the recalls, but use Dr 1 if there is no Dr 2.

### (41) Clinical analysis report - demographic

For any range of dates, any range of processes (ask Rob) and with a wildcard on male/female or both, for each process print:

- \* The process name
- \* The number of patients with the process
- \* male/female split
- \* age breakdown 0 - 10, 11 - 20, etc -> 90 +



42 Clinical analysis report - disposals

For any range of dates, any range of processes (ask Rob) and with a wildcard on male/female or both, for each process print:

- \* The process name
- \* The number of patients disposed of by each disposal method

If this report will not fit across a page, use more than one line per record.

43 Clinical analysis report - treatments

For any range of dates, any range of processes (ask Rob) and with a wildcard on male/female or both, for each process print:

- \* The process name
- \* A list of all treatments given to patients with the process
- \* The number of patients with the process given each treatment

44 Clinical analysis report - list of patients by process

For any range of dates and processes, list patients' names, registration dates, cas no and date of birth by process.

Reg - Specialty Analysis

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## Appendix 6: Sample Interview Transcript

The main part of the data collection exercise comprised a series of unstructured interviews that were recorded and subsequently transcribed. Twelve hours of interviews were conducted. The interviewees comprised:

- sister in charge (grade G)
- charge nurse (grade F)
- two experienced staff nurses (grade E)
- junior nurse (grade D)
- senior A&E consultant
- senior house officer
- house officer

The interviews were conducted over a three day period, and the resulting transcripts amounted to over 50,000 words.

This appendix provides a sample interview transcript of one of the interviews conducted during the study.<sup>1</sup>

### Sample Interview Transcript

- R2 = Junior Nurse (Grade D).
- I = Interviewer (the author).

I : Could you talk me through what you do here in triage?

R2 : Well, it's a hell-hole. There just isn't enough staff. Now that it's on computer, now that we triage first, it does go back to more hand-written stuff, whereas the old way, before it was on computer you had to remember to knock the timer off etc. etc. But now you can go back to that afterwards, with the list of people that you must knock off the screen, so you can tell whether they've gone to majors or minors and what

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<sup>1</sup> Space limitations preclude the inclusion of the transcripts of all the interviews.

category they were, you know non-urgent, urgent or immediate. So you use the computer for that.

I : But you do that after you've triaged them now, so you do the little...

R2 : Do the little white slip, and then they go and book in.

I : What's on the little white slip?

R2 : What their name is, what's wrong with them, which category they are, priority, and whether they're going to majors or minors. And that's it. So when it comes back to you it's on a proper card

I : With that little label. Do you stick that little label on?

R2 : No.

I : It goes with the patient?

R2 : And then give it to the clerks, they then book themselves in and then take the piece of sticky and puts it on the card and then it comes to me. I just put it in the appropriate box so that it goes to majors or minors and what order I want it to go in.

I : Right, and then someone else will come and collect them

R2 : Yes, majors or minors.

I : How often do they come and collect them?

R2 : The majors a bit more slow, they might take one at a time when they get a cubicle available they come down and take one person for one cubicle. Minor injuries take about half a dozen at a time and take them through to another little waiting area where the doctors will call them in - four per take - sometimes they take more at a time just to fill the cubicles up. So they're coming more often as they're taking far more patients. They get more patients in there. So we don't use the computer for that.



- I : And when they're coming through do they sort of get in the way or is it actually quite nice to have someone disrupting you as it were.
- R2 : Well, it is quite nice to get disrupted in a way, but if you're very very busy then they also get in the way, but it is a time when you can hand over certain bits of information. You have people come in that you want to hand over - their relatives dying and that's why they're upset and that's why they upset others down here. But, if you haven't had a chance to get away because you can't do the triage to hand it over, it's nice when they actually come down you can then give them some handover, all the little bits of information that you haven't got a chance to write down on that white piece of paper, but will have some bearing on their care. So a brief handover, where the relatives are and things like that. Where they've got the keys to their flat or whether they forgot to bring them and things like that.
- I : So the little human issues that aren't necessarily...
- R2 : Haven't really got to be documented
- I : But are quite good to know. Because patients get a bit fixated about certain things, I suppose, don't they?
- R2 : Well, it's very important, lots of little things. I mean, if you tried to send someone home and didn't have his keys to get in, if you send him in an ambulance, you've got to make sure he has the keys, that kind of thing, so it is quite important. You don't get much time to do that really, you could do with a bit more time, to do that. Quite often, the triage nurse is so busy, minor injuries people come in, take top half-dozen and off they go. We have been able to spend less time with a patient in triage now, now that their being triaged first rather than booking in first.
- I : So actually, that's had an effect. It's not just that there's loads of, that you've got a time constraint, it's actually now that it's swapped round.
- R2 : I don't think that the new triage system is very good for the patient, it meets the Patient's Charter, but its not necessarily good for the patient, because if you've got ten people to book in, you're not going to take as much information because you can see you've got a big queue. You're going to say, 'you've got a pain, you've hurt your arm' that's it, rather than how did you hurt it, how long ago, will you put it up in the air, have you got a pulse there, this kind of thing.

I : So all the things that sort of comfort them a bit.

R2 : They get less time. It's also bad for confidentiality, whereas before they used to come in periodically across.

I : So now they're actually backing up?

R2 : Yes, because they used to be backing up outside the clerk's desk, which was not quite confidential because they ask about address and name, but it's nothing particularly personal, whereas now backing up at the triage desk, the next person behind knows your personal problem. I don't think it's necessarily very good for the patient, but there again it meets the Patient's Charter.

I : So does that mean, have you have cases where people have actually not told you what's wrong with them properly, been embarrassed about it?

R2 : Yes, well they wouldn't tell you as much because they know there's another person standing behind them.

I : And, for you the time pressure is that you also have to be doing all the little slips filling in, so you don't want to take ages on them because you know there is a queue and you also know you've got to write it down. What about the phone calls that you get in there as well? So you've got the advice line...

R2 : You've got the advice line coming through, which is quite frustrating at times, but I think it is a very necessary thing, I very definitely agree with it, for you can advise so many people where to go, and we won't get to see so many inappropriate attenders in the department

I : And that has to be a senior nurse?

R2 : Yes. They have to have been in the department for six months. I don't think it's organised enough yet. I really think we should have some kind of...another computer terminal especially for that, where you can log people's names in rather than .. at the moment if you get time you bother writing it down, what the name was, what the telephone number was, what advice you gave. Sometimes it gets forgotten, some people don't bother, sometimes there's not a piece of paper there, so it doesn't



get done. I think it should definitely be a formal thing because more people would take account of what they say, because somebody could come along and give you some advice and then when that person may advise them to come in, they say I've been advised on the phone to come in, and if they haven't written their name down it's anonymous, it's just a nurse at the other end of a telephone, where you should be able to look back at this piece of paper that we've got, but I think it should be on computer. I also think we should have a database of what to ask, so if you put into the computer that they've got vomiting and diarrhoea, and then it can give you a list of points to ask, just to help you.

I : Because at the moment that just relies on your experience and knowledge. So how do you make a decision like that, you basically just...

R2 : Purely from your knowledge. That could be different for different people. Some people might think it's not very urgent and some might. It's not very common that happens because you've all been trained the same, but I think it would make it far more formal rather than, there's nothing advertised either about it being an advice line. It's just people who have actually had the common-sense to say 'well I'll ring the hospital first of all'. But I think that's part of the waiting time initiative we could make, is a formal advertised advice line, and that's why it should be more formalised.

I : So you're coming at it really from the point of view of the patient really, and saying this -- what happens for instance if someone gets advised from here, 'Oh just go to your GP'. Do you ever get a comeback, say somebody was taken ill, say seriously ill, and they went to their GP as it were, and something happened in that time lag, do you ever get a comeback where the GP says 'did you phone the hospital?'

R2 : No, we never get anything. Whatever advice you give, never... The only way is, if you advise somebody to come up, and then an hour later there and you say 'look you booked the person in'. If you recognise if you spoke to that person. That's the only way you'll get any comeback. So much advice has been given wrongly, far more used to be because the receptionist used to give out advice which they got into a lot of trouble for, so now they have to keep the name of the nurse that they put the telephone call through to. They've got some kind of call-back on it. But then the rest of the call is written down.

- I : So they could more or less claim that they said anything that they wanted. And you don't think that it would be a problem, it would just complicate your lives even more having to formalise
- R2 : Well, it would if you had to use the same computer you were supposed to be triaging. You couldn't do. You couldn't go off the triage screen and into another one. It would have to be completely separate, which then goes down to space and all sorts of things, and cost and everything else.
- I : What about timewise, though, I mean would you actually have the time to put details in?
- R2 : Well, you're supposed to have a time to be able to write down the persons name, their telephone number, what the problem was. So you should theoretically have the time to put it in to the computer. But then again, that's building up the triage nurses job even more. I don't necessarily feel it should be triage nurses.
- I : Yes, I was wondering, I was going to ask you that.
- R2 : I think it should be the desk, possibly just on the nurses station in majors and, or possibly minors, somewhere. It's a different colour phone. Anybody can answer beyond a certain grade. You can have a little computer there tapping in their name and everything. But anybody can answer it instead of just walking past. That is only going to be an advice line, nothing else. I think it should be one telephone number and nothing else, so I think that leaves too much for triage nurse really.
- I : What else, so the same phone that you get the advice calls on you also get calls from relatives?
- R2 : Relatives, enquiries after patients. The clerks have tried to take more of that off us, about .. enquiries because it's taking up an awful long time and you used to get the GP come through there, but we don't get that anymore which is quite good. So a lot of it is just enquiries about patients.
- I : And it only comes to you when the receptionist can't give all the information?
- R2 : Yes. Well they just look and make sure that the person's card is still at triage which means that the person should still be at triage and then they'll ask. If the card isn't



there, they've gone through to the department and then they'll pass it on. That's where it goes wrong sometimes because it's up to the clerks to come round and look thoroughly through the cards and if they have it a quick look and they can't see it, they put it through and then we'll try and find the card and then if it's not there, it must have gone through. So you walk down and they have actually gone through into the department but

I : Because R1 was saying this morning that he gets something in minors or majors when it's busy, so just at the time when you don't want any phone calls they're getting about one every five minutes or something like that.

R2 : Yes, I was there on minors at the moment. Yesterday I was very frustrated and I was even answering the phone, my manner in answering the phone, you could tell I was frustrated .... by the ringing, because I was on my own and I'd got four doctors working with me so, for every four dressings the doctors asked me to do, there was me. So I was getting four times my workload, so I was so frustrated I was keep answering the telephone and it was about patients, particularly in the minors, because there's such a large stack, and we don't have the patients' names written down somewhere like we do in majors as to whose in what part of the department, trying to locate them, they could be in the sub-wait, seeing a doctor from there, or they could be in a cubicle, depending what's wrong with them, or they could be down in X-ray . There's absolutely no way, we don't trace a patient in minors.

I : So when you get a call, you have to just basically wander around the cubicles?

R2 : Wander around the cubicles. If they're not there wander out into the sub wait corner, if they're not there, presume they're in X-ray . Just presuming they're in X-ray isn't very good really. You should know they're in X-ray . That's another way that we lose patients along the line. That's something else I've thought about. Actually tracking the patient.

I : Yes. You see this is the sort of thing that I'm mostly interested in because this is the sort of thing that would help you rather than hinder you. What's the reason why you don't have a white board in minors.

R2 : Because it changes so quickly you'd spend more time writing people's names and rubbing off. Because the doctor will go in and say 'umh, you've sprained your ankle, we need an X-ray on that' and your out.

I : Then you come back and then your in a different cubicle and so on.

R2 : So you'd have to be continually writing names on and off the board, it would just go so quick you'd spend a long time writing. On the same hand I think you need, you don't -- patients take their card down to X-ray with them, so you've got no record of the people that are in X-ray , which I think there should be a system somewhere where they either leave their casualty card behind. The idea was we were filling out an X-ray form. Used to be, you just have to write on the casualty request card - arm X-ray and that was good enough. Now that the ... gone computerised they have to have a special X-ray request form which means the doctors are writing out everything again. So they agreed, as long as the casualty card was there with them, that the person in X-ray could copy down all the address, telephone details, everything, from, then they only have to write arm X-ray on the form. So that's why two cards go down, whereas if you've managed to keep one card, the casualty card in X-ray , it means that every detail needs to be copied from the casualty card on to the X-ray request card.

I : And they do that once the patient arrives at X-ray ?

R2 : No, no, no. It's done by the doctors, you see, which is cutting down the time which the doctor spends with the patient because they either have to bother writing everything down, because if they don't bother writing it down it means it's on the part of the casualty card ... as well as the X-ray request form, which is why we lose the card. Which is why we don't know whose in X-ray. I mean, at night time, when X-ray requests are sent down a couple at a time it's easier to keep tracks on people, and if you're only on your own you really have to keep an eye on how many people you've sent down to X-ray , otherwise you'll get half a dozen coming back at once and you've nowhere to put them. But if you've got several doctors who are trying to get down the waiting time.. I couldn't keep a track of how many I've said 'there's your card, take it to X-ray '. I couldn't keep track at all of whose in X-ray.

I : So the doctors don't necessarily tell you who they've sent down to X-ray, and you don't send them, the doctors send them?

R2 : If it's someone who needs pushing down to X-ray because they're on a trolley or in a wheelchair, we often get told, but if it's someone whose walking, then no, quite often we're too busy.



I : So the doctor will just hand them their card and say 'it's that way'.

R2 : It depends how many nurses in ratio to doctors there are, sometimes you can be working with only one doctor and there's three nurses, so it's very slow for us, because each treatment means there's three people fighting for, but when it gets very busy, and there may be five doctors and there's three nurses, you lose track of what's going on in the department and whose gone to X-ray, etc. etc. because as soon as you go inside a cubicle, shut the curtains, do a dressing, what's going on outside you just goes, you lose it, so you need to keep coming out and checking really what's going on.

I : And the doctors hardly ever use the terminals, do they, the computers.

R2 : No, they don't. Even if the patients gone to X-ray, or if they discharge a patient, it's supposed to be a qualified nurse who sees everybody after the doctor before they send them home. Just in case it's supposed to be a safeguard for the patient, really, just in case you disagree with the decision, or a lot of it the doctor won't take any social circumstances into account. They thought a nurse would be able to do that a lot better, they're sending people home without keys, and without any method of getting home and things like this. So, a qualified nurse is supposed to see everybody, but there again, that's impossible sometimes when you've got four doctors and two nurses on minors, because you just go in to do a dressing, and they say, 'there's no point in you hanging around just to see a nurse' and they send them home. They just put the card down for you to book out and, there was a stack yesterday of cards just put by the computer, then when I'd got a moment eventually I still had to go and book twelve off at once, you know.

I : Does that mean that the times are actually wrong when the patients were actually discharged?

R2 : Could be. If they actually bother to write down the time they discharge the patient, or they just write 'discharged to GP' I've no idea what time that person left. The senior doctors are very good, they just sign their name and write the time, and then I'll come along and change the time on the computer to the same time as they've put. But there are so many session doctors these days, that's not often getting done so I just come along and find twelve there that I've got to book out and I don't know when they went, but then again that comes into accountability, I've not seen

them go, but my names on the computer, so therefore I'm the person whose responsible for letting that person go. So you then end up writing on the card 'discharged by Dr. not seen leaving by nursing staff' to cover your own back, which is awful. But otherwise, my names on that computer as discharging them.

I : And is there anything in the Patient's Charter about, I suppose it doesn't matter how long they're in minors, so it doesn't matter if you just put - if you don't know the time, you could just put

R2 : Just put what you want, but then again, statistics wise, that messes things up because if I actually get round an hour later discharging on the computer it looks like, although they were seen by a doctor at a certain time, looks like they were in the department somewhere stuck there for longer.

I : That's interesting. So do you ever sort of guess at times, 'well that's at the bottom of the stack so that must have been half an hour ago'

R2 : Well, I've seen that doctor doing stitching for the last five minutes so it must have been about ten minutes ago he saw the last patient, and that's it - a guesstimation. Does go different methods as well, if you get two doctors going, sometimes you get a bit of wait up, you can have a doctor sitting at a desk and calling a patient to him, whereas a doctor going from each cubicle to each cubicle, because some of the very minor things don't actually necessarily get into a cubicle. So at the same time often we have one doctor sitting at a desk, that's the senior doctor, looking at all the walking wounded, who can just hobble in, sit down and go to X-ray, and one doctor going round the cubicles looking at people who need to get undressed a bit more because they've hurt their shoulder rather than something which can be looked at a desk. So there's two methods of doing that.

I : And in that case, then, all the information about -- so assuming that, say this is in majors with the board, I know it isn't, say you had something similar in minors, then in that case, these people would be like floating voters as it were, they'd have no cubicles.

R2 : Yes, there's just a stack of six on his desk, he just shouts for the next one.

I : And with these one's they either go out quite quickly or they get allocated a cubicle.



R2 : Well yes, that's the other problem. You have to try and leave a cubicle available to go and do the treatments that doctor - if you've somebody sitting at a desk, you really need one nurse to that doctor and a cubicle next door to whatever he says 'right go and see the nurse and she'll do the dressing', whereas if you've filled up all the cubicles with patients waiting to be seen by the other doctors, then you've got nowhere to put them, so then sometimes they're sitting outside back in the sub-wait because if there's no cubicles available the doctors will say 'have a seat back out there in the little waiting room just opposite, and the nurse will call you through in a minute'. So sometimes they're then waiting quite a time just a stack of treatments builds up, or if you're short of nurses, just be called through.

I : 'Cos you don't get the time to actually look at the stack and say...

R2 : That's another thing. When they put them in, the doctors put them in. I don't know which way, sometimes they just throw them in and then the nurse comes along and takes the top one - that's the last one that went on and the poor person whose underneath - I had ten waiting for me yesterday - but some doctors put them at the bottom thinking you're going to take them from the top, some just throw on the top thinking you're going to take from the bottom. So, like a say, if you've got used to working with the doctors, like the senior doctors, that work round here quite often you know how each other work, but with so many session doctors, these days, it's very difficult to know which way they're going to do it and you're going to do it, you have to actually say 'which ones are you putting at the top first or at the bottom first?'

R2 : Another thing that goes wrong, sometimes people when they come back from X-ray, they've been seen in a cubicle, they just go back automatically to that same cubicle, thinking it'll be empty. If it's someone whose in a lot of pain or on a trolley and can't move and things like that, if it's broken ankle or something like that you save the room. But to try and save time you can't save every room because otherwise you'd have six up in X-ray and nobody in the department, you'd just be literally waiting for them to come back. So to save time, you see other people. So if that room which was then free, isn't free, you then have to find another room or just put them back out into the little waiting area until you've got a cubicle available, so sometimes that goes wrong. Also, sometimes they come back and don't hand their X-ray s in, they just sit there with them. .... and you see someone sitting there and you think 'he's got an X-ray folder'.

- I : I suppose it makes sense, actually, because they probably view them as their X-ray s.
- R2 : Yes, and more polite people will wait to be called, but if we don't know their back from X-ray.
- I : So actually once they were, say you were linked up to X-ray, if X-ray were to inform you that someone had left, would that be an advantage?
- R2 : No, not really. It just helps to know whose in X-ray. Then it's up to them to come and bring themselves back to here and then you can now say 'there back from X-ray' and now they're back in, that's the bit that needs whether they're there or back in. The other problem now, now that the nurses are triage at X-ray, trying another waiting time initiative. Because nurses can now request X-rays, so they lose patients that way as well. They've got no way of tracking a patient that goes in X-ray. Once you've got a triage where you think it's an obvious break, there's no point in waiting to see a doctor and then the doctors says yes. If you've obviously broken it, go and get and X-ray.
- I : So the triage nurse will send them straight to X-ray.
- R2 : Straight to X-ray. Which means they're in the queue (in the pile) and then they send them to X-ray. The things that go wrong are one they suddenly end up in minors, and they bring you back the X-ray, and 'oh yes, take a seat in that cubicle there' having thought that they'd seen a doctor. Then look at it and think I can't find the casualty card and yet you've had an X-ray. And you say 'which doctor did you see?' and 'I haven't seen a doctor'. And right, back out to triage, they've missed out the doctor bit. So, they get sent up to triage, and if something's broken then obviously we put them near the top anyway, but it's up to triage nurse really whether she just feeds them in the normal system in their time queue or whether she puts them up a little bit if it's a definite break or whether they come straight down to minors. But if they come straight down to minors then they really are queue jumping, just because they've had their X-ray by a nurse, they've jumped the queue so we quite often have to send them back out to the waiting room and give the X-ray s to triage nurse, and let her prioritise them, and then they come back in, it just means when they get to the doctor they say 'here's my X-ray' and all of that saves time that way. The triage nurse doesn't know how many she's got down in X-ray, so that's something that annoys them as well.



- I : So she doesn't know where they've gone afterwards, so she doesn't know whether they've gone straight to minors?
- R2 : No, it's up to them. If it's an obvious break they sometimes come straight down to minors if it's a bad break, then we have to go round and find the card because that's still at triage, and this kind of thing.
- I : So do you think the triage nurses... well, do you ever say, if you've recommended someone to go and have an X-ray, do you say 'come back to me?'
- R2 : Yes.
- I : You normally say that. So it's only if the radiographer sends them to minors...?
- R2 : Just because people get lost as well. Tell them to come back to me, but they didn't quite take account of where they are, they walk off to X-ray, they're more concerned about their injury obviously, I mean that's just natural and then they think 'where was I?'. And they end up in majors, minors, on the corridor, they end up in clinics. We also do a fracture clinic, they could end up round there.
- I : Actually it makes sense your patients going to the fracture clinic if they've got a break. If they're wandering around and they see the sign. Do you think, you know, like when you go to your GP, a lot of GPs now have computers in their offices and they're quite happy to use them, you know they use them most of the time, so why do you think that doctors here seem reluctant, do you think they just don't see the need, or they don't see there's any benefit for them?
- R2 : They don't see it as medical, they see it as purely admin. I'm here to be a doctor not to do admin. But I don't think, yeah, also time, the number of terminals available, sometimes they're so blocked, that I think if a doctor wanted to get into it just to check a certain job, he wouldn't disagree with it ... what GPs often use it for, then they'd have to wait to get into it. But I think they see it as admin, below them.
- I : But they expect you use them?
- R2 : But I mean it is .. it would be if you insisted that every doctor who discharged a patient, put it on the computer, I can quite see that it would be a waste of their time, because they'd have to get up, go to the computer, get into it, where now they just

walk past and throw it at the computer 'I know it means the patient's gone.' After all, that's what the patients here for, to see a doctor, .. without giving them something else to wander off on. Did anyone talk to you about the Nurse Clinician?

I : No.

R2 : Right, the Nurse Clinician, .... very minor things that an experienced nurse can see, don't need to see a doctor, ... there must be about ten nurses now in the department that can see a patient on their own without seeing a doctor. They've got a big list of protocols as to what can and can't do. They can X-ray certain parts of the body, and they can treat them without seeing a doctor. Now there's no, on a triage, when it comes up on the computer or when you ....there'll be nowhere, even on a casualty card, that says 'this patient in the triage nurse's opinion, could be seen by a Nurse Clinician. If there was some way of documenting whether they could be seen by a Nurse Clinician, as this person comes through to minors, she picks up the first half dozen, just reel them off in front of a doctor. Perhaps there could be some way of alerting them either on computer or either on the CAS card, or somewhere that they could be seen by a Nurse Clinician if we've got one around.

I : So it's not simply enough that they've got the star priority, because you do know that. Because you know when someone is a priority or less serious or so. Is that right? So in triage, you do prioritise them don't you?

R2 : Yes, you just write it down one, two, three, four.

I : And whether they can see a Nurse Clinician is sort of related to...

R2 : .. in that little bit of communication where .. comes through, pick up six cards, if the triage nurse is available, but she might not be available, she might be taking blood out of somebody's arm. Then we miss that little bit of communication

I : So it's not just that it's someone with a three, then they could see the Nurse Clinician?

R2 : No, it's a bit more complicated than that. Because it's very new, they've got very strict guidelines on what they can and cannot do. .... that little bit of time and communication about that person's very deaf from over there you've got to shout



loud or else they're going to sit there for ever. And, like you say, ... if they've got time. But if you don't see them, then you lose that little bit, so...

I : And the triage nurse can make decisions?

R2 : Yes. If it's that minor, the cut, you could actually treat it at home yourself. Then, so...

I : That would actually speed up the processing...

R2 : ... I'm not quite sure really, I mean it could be looked at anyway.

I : I think the whole business about tracking a patient seems like it's a good, it would be a candidate for improving, because it's one of the things which seems crucial to all your activities, and yet is not very well supported.

R2 : Then again, you don't want to spend too much time putting everybody's name in.

I : No, you wouldn't want to do that

R2 : Each time someone .. type in everybody's name.

I : Unless it was already there.

R2 : Yeah, ... a stream somewhere in minors, with everybody's name on it, you just went up to it, tapped it, in X-ray. Tapped it twice, they got lost there as well. Yes, it's definitely got to be that way, which is going to mean... you'd have to I think have two terminals, maybe,

I : One for discharging and one for tracking. Because the tracking is really the sort of think you just want to be able to walk past, you don't want to have to queue up to use it.

R2 : Yes, to put people's names in, that would then slow it down.

I : Yes, and that would be a waste of time.

R2 : It's a matter of number of terminals

I : And space and so on.

R2 : .. majors and minors ... equipment and a computer. .... appointment to come back which I think is quite good, how it's done at the moment, just tap it in and it comes up with all the dates for the A&E clinic, and you just look at it down whatever date you want, but why you can't do that with fracture clinics I don't know.

I : I notice you've got a fracture clinic book and .. ear, nose and throat. Yeah, that seems a bit odd to me. It didn't seem to make sense that you had people running around picking things up, unless once again you need this little exchange of information.

R2 : The only reason I think that the fracture clinic isn't done on the computer is because a women comes round, a clerk comes round from the fracture clinic every morning and takes that one sheet out. It's then her responsibility to find all the CAS cards and all the X-rays. But, it could all go on computer as well, I'm sure. Why couldn't they go into their computer and find out if it's good as new, which means they wouldn't have to walk round to our department, they could do it on their computer. Well I don't know why that isn't the same as the A&E clinic.

I : Yeah, I wondered that.

R2 : Anybody, if they make a redressing clinic appointment from obs ward, that can be done from their terminal. Whereas before they had to come all the way down, get the redressing clinic book and go all the way back again. That's much better so I don't see why fracture clinic can't have done the same.

I : And how could the CAS cards, if they were to do it over in fracture clinic, the CAS cards for that list would just be sent across from here. Would they have to request them, or...?

R2 : They may still end up having to pick them up from our reception. If they're going to a particular fracture clinic they stay there until the next morning the woman comes round and gets the piece of paper with the names on, she then has to go to reception to pick them up. She'd may still have to pick them up but she wouldn't have to walk round and get the piece of paper.



I : She wouldn't have to come through and get in your way when you're trying to...

R2 : It's probably easier for them as well. Have you spoken to anybody from X-ray ?

I : No, not yet.

R2 : X-ray's all over the place. It's another thing... when we book someone out to Alderhay Hospital, something like that. It's up to us to remember to come down to X-ray and book out the X-rays. They go with the patient to Alderhay Hospital. If we didn't remember to book out the X-rays, and then the patient comes in here a year later and we're looking for those X-rays, they'll think they've vanished off the face of the earth, because someone's forgotten or not had the time to come down and say when they've gone to Alderhays. So I don't know whether that could be, 'cos we book a lot of people out to Alderhays, once we ... and I don't know whether we can do that from where I am now, rather than having to walk round, and out of the department, write it in a little book, these X-ray numbers have gone to so and so, whereas when you're discharging a patient you discharge them, got it confirmed, .. Walton Hospital, because we send quite a few to F ward. Why can't you say that the X-ray got lost and .. going to Alderhays, we've got a thing on the discharge says going to Alderhays, so why can't we say an X-ray has gone with them.

I : And it doesn't ask you that. And all of that would be kept over there presumably? It doesn't come back?

R2 : No. What else...

I : Is minors the problem really, the problem area out of all of them, do you think? I mean, I know triage is like a sort of, a war zone, but majors seems to be quite a sort of social hub in a way. You know, you've got the control desk and everyone hangs around it,

R2 : Oh yes, you've got doctors and you've got people going up and down there. Mind, you can be quite out on a limb because you're physically across the way, and so you don't automatically interact, you needn't see one of the majors all day if you don't want to. You're out on your own. It's not a problem, but because of these where are minor injuries it can tend to be forgotten, sometimes. You just get on with it and it's only when .. I've now got three and half hours wait, please can I have a doctor, and it's only then that they really interact. Please can I have a doctor, and then they get

a doctor and .... so it's only that you could be out on your own on a limb, when your .. as a triage nurse.

I : Do you personally work in majors as well? You do...

R2 : You can see what the problems are both sides, and being at triage, I mean it's very frustrating, particularly yesterday when I had so many trolley patients that needed care. I had two or three medical and surgical that were blocking my cubicles that I could then no longer see, the minor injuries patients couldn't get seen .. because they were blocked with the majors patients. So that's frustrating for me. When I go down, see the triage nurse, then I realise that's it a war zone down there, and I remember what it's like myself and I think what a mess, I'll go away.

I : I'll go away quietly! So they actually send, when majors is full, they send majors into minors.

R2 : Well, when they've got a lot to go into majors, then it's a case of thinking what are the lesser ill majors that you can then go into minors just to give them to the majors coming in. Otherwise, you end up with a situation sometimes when minors get seen far quicker than the majors. If you think about it, it's completely wrong. Someone with an injured wrist shouldn't get seen before someone whose got chest pains. So you end up stopping them sending to majors, giving a few to minors and then the people with minor injuries just have to sit and wait. You have to ask as well to change the time on the board. Have you seen our waiting time out in the front there?

I : I've seen people wandering out and scribbling on it.

R2 : Could be in two and half hours out there. Just an idea to keep patients informed.

I : Yes, so at least they know they've got a long while to wait. And someone from each of the areas must know. I notice the triage nurse pops out most of the time.

R2 : It used to be. We decided now, the triage nurse doesn't know what's going in minor injuries. They don't do it really for majors any more. It used to be for majors, but it's mostly for minors, so it's either the nurse from minors will come down and keep updating the board as well, just to make sure people know. I'll tell you what I think we should have. .. displays that you get across .. with little red dots on that go



across the screen. Well, I think we should get messages on there. I think we should have one. Because otherwise, all it gets to a certain delay, although you can write on there the wait has gone up to now 3 hours you can't say why. And when the wait does go up, one way of satisfying people is to tell them why it's gone up which just means finding the guts to stand there, in front of people, and the whole list if you've got twenty five to thirty people waiting to come into minors, you say, all those waiting to come into minors please listen and the waiting room is a mess, and the noise, and you've got to try to stop them all, and say the wait is for reason this, because one doctor gone to lunch, rather a lot of stitching going on, or there are so many people with broken limbs, this kind of thing. Which, one ... the other one will get up and start shouting at you. Takes guts.

I : I think there are three hours.

R2 : Whereas I didn't know if we could have a little labels with ....

I : Well, I can understand it. Because you don't want to take the flack...

R2 : And also, you could get done more if it was that way, whereas you're having to take the time out to come down, pick all those cards up, list all those names out, 25 names, and say this person is ... 'you're waiting to go into minors ... Whereas if you could tap them in you could get done a lot quicker.

I : It's a good idea though. At least let people know what going on, and not expose you to the flack. Do you always give them good reasons?

R2 : No, it's very hard to tell someone they're waiting two and a half hours because a doctor's gone to lunch.

I : A doctor's gone to lunch. Yes, I can imagine. No, no. You can say there's a shortage of doctors.

R2 : Yes. We say, obviously, it's due to a changeover of doctors like at one-o'clock, due to sickness, or sometimes it's down to one nurse, due to sickness or nursing staff. Or, I don't mind saying, if there's lots of broken bones or there's lots of stitching going on, people needing stitches, takes time. Or dislocated a shoulder - time to put it back in, so that kind of think is perfectly acceptable, but to say that someone's gone to get something to eat is just unknown, which they've got to have something.

They work ten hours. But trying to say that is just - I wouldn't necessarily put that over on the message board.

I : You'd put something, though. What about in majors, are there sort of, what are the problems that characterise majors from a tracking point of view.

R2 : From a tracking point of view. When they go to X-ray . You don't know that your patient has gone to X-ray . And it's fine if X-ray are on top of it, shouldn't be there long. But, as soon as it gets a fair few, they're around there for some time, and think - Oh. At least this way you do still save their room for them, mostly. Out of the ordinary not to save the room for them. If you're that desperate that someone's got to come in while that person is in X-ray , you'll take them to the cubicle, but it's not the norm. So, if you've got an empty cubicle and you've normally only got seven patients to look after and then you can remember them. Most times you remember where they've gone. So that's one.

I : What about the updating of the board.

R2 : Once they've been seen and waiting for wards. Sometimes it's quite a wait to actually get someone to the ward, you just move them off the main patient board and their just stuck in the corner (of the board), this little corner can have about eight people waiting, and everyone's in tiny little writing, you just put the initial by it, by name and your initial so that you remember that persons responsible for them, otherwise they can get forgotten there, sometimes if they're just waiting for blood results, you move them out so someone else can get seen. They're just literally sitting there in that holding area just waiting for blood results. So that's were tracking wise that way there still on a tiny little corner of the board, you don't officially know what they're waiting for. You just remember.

I : What about the movement between cubicles, so that, on the right hand side you've got something like whether they're going to see a CAS doctor or a medical and so they're moved from that over to, is this right, they're moved from there over top which cubicle they're in. Oh no, it's cross-reference isn't it, so the cubicle and the name and then the cubicle number down that side.

R2 : That system seems to work quite well.

I : And you don't get lots of rubbing out and moving around and...



R2 : No, not really. Unless you've got someone, someone comes in, I say the more the problem was out of triage, the fact that someone comes in and they've been to see the CAS doctor then referred to the medics. So they've been in the department longer, someone comes in waiting to see the medical specialist, so they've been supposedly referred straight to the medical specialist but those, so you suddenly got medical 1, 2 and 3 on the board, and there's maybe 5, 6 and 7 out in triage waiting to come through. And then the problem comes when you've got one of the casualty patients been referred to the medics, where do you put them? Do you put them as number 4? As the bottom of those that are in the department? Do you put them in behind everybody else, because they're supposed to be waiting to see the specialist number 9. But, because they've been in the department longer, do you just slot them in somewhere. Which means that quite often you get people who are medical number 6 and suddenly their medical number 7 and suddenly their medical number 8.

I : Presumably the patients, do the patients ever, can they translate what's going on the board, I suppose if they see their name dropping down the list?

R2 : Sometimes you write it up on CAS cards to cover your own back so you won't get complaints back later on, what happened to this patient, 'why was this patient in the department for two hours?' you can say well they were medical number 2 priority, but then they got pushed down.

I : So you do occasionally get complaints from relatives?

R2 : Occasionally? Often. About why they're in the department so long. And it's up to you, if you sign that person, your name's on that card somewhere, they'll come to you. Then you can get called into the office, probably about six weeks, two months later, and asked 'why was this person in the department so long?' So you've got to try and write something down if they've been pushed down like that, or something like someone was called in to resuss, and therefore they're not going to be seen for a while. You have to write it down, the doctor's busy in resuss therefore - otherwise you've got .. but they're perfectly entitled to read it if they like on the card, so they can see that they were medical three, then medical five, then medical six, but if it's a person see that had been seen by a casualty doctor first of all, and then they were put to medical number nine, they have been in the department longer.

I : And there is a little pad on the desk, isn't there, where you keep a record of the number of, is it the number of complaints that are coming in?

R2 : No.

I : Relative to the number of doctors that were on?

R2 : Right. No, that's the number of people who are waiting to be seen by medics. We have more trouble with medical doctors. What we were saying was that medical doctors kept disappearing off the department to go and see, 'cos they have a ward of responsibilities so they have to keep an eye on those as well, and each time there's a cardiac arrest in one of the wards they've got to disappear and they kept saying that, each time this happened, we were getting less and less doctors on the department, medical doctors, and it was their patients which were waiting. I've seen medical number 17 waiting to come into triage. So, you know, that person's going to have five or six hour wait in triage before seeing a doctor. So that's why they said, right, we'll keep a record of how many medical doctors there are in the department and how many patients are waiting. We've got one doctor with only two patients, then fair enough, but when we get to medical 17 there really should be more doctors in the department.

I : And there's not very much which is done about that at the time? This is really just a way of keeping a record of what's going on?

R2 : Well, it was done originally so that we'd realise the wait was going up. You could call more people down. And it's also the medics, cos they have arguments where they're saying they do send medicals down, and we're saying but you don't. So it was decided, we'll write it down and see what happens. That's what that's for.

I : Put the pressure on them a bit...

R2 : Yes, because then the whole business of the department is completely a medical problem, it's not an A&E problem. If you put such a large number of people referred from GP surgeries - most hospitals have been, and used to be in this hospital, sent to a completely separate GP referral Unit ... Well they're all one now, and we have this ginormous .. mainly from those that were referred from GPs. So, we don't want anything to do with the GP referral system anymore. That's where it's all basically going to fall down. We want to get rid of it, we want them to go out on their own.



If they go out on their own we'll lose an awful lot number of staff, because we've got such a high number we're allowed more nursing staff. If we split up, we'd lose the staff, but they want to stay with us and we want them to be separate. That's what the argument boils down to.

I : And do the people who've been referred, do they tend to be less serious?

R2 : No, we get some really poorly people coming in from GPs.

I : So people go to their GP first?

R2 : So tracking in majors really isn't that bad. I mean it is, if you have somewhere like, someone goes off to CT scan, someone goes to a specialist X-ray, think of some way of tracking those. But then they'll obviously be so few that it's obviously not often in your mind, they're quite poorly, you remember them. It's only the minor things that you don't remember. That's why in minors you don't know anybody. It's awful, on minors, they just get to be an arm or a leg. You don't get to be a person anymore.

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At this point the interview was interrupted, and it was time for the nurse to return to the department.

I : Well I think that's about it, that was very good. Thank you.